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Physical Interpretations of Relativity Theory (PIRT) consortium arranges conferences and publishes books to explore the chief characteristics – including the advantages and disadvantages – of the various physical, geometrical, and mathematical interpretations of the formal structure of Relativity Theory, and to examine the philosophical, geometrical, and mathematical interpretations of the formal structure of Relativity Theory and to examine the philosophical and other questions concerning the various interpretations of the accepted mathematical expression of the Relativity Principle.

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Visual Cryptography and DNA Secret Sharing: Two Simple ways to Store Secret Information in a Secure Way

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Due to the recent development of quantum computing and attacks on some of the modern cryptographic algorithms (such as DES, and more recently, MD5), the new directions of information security are being sought to protect secret data. The concept of using DNA computing in the field of cryptography is a possible technology that may bring forward a new hope for powerful algorithms. In this paper, we put forward a new technique for perfectly secure secret sharing schemes using DNA computing. The aim of the paper is to establish interlinks among four different subjects, namely mathematics, statistics, cryptography and DNA computing. Using linear algebra, partially incomplete block designs and DNA computing techniques, we develop perfectly secure DNA secret sharing schemes for threshold as well as for general access structure in which a secret message may be distributed among a set of participants in such a way that certain designated sets of participants can reveal the secret message but certain designated sets of participants have no information about the secret. One of the major advantages of our scheme over the other computer based secret sharing schemes is that it provides not only the computation security but also the physical security of the shares carried by the share holders. In paper we shall emphasize how abstract and linear algebra may also be used in constructing another special kind of secret sharing scheme on a set P of n participants, known as Visual Cryptographic scheme in which a secret image, consisting of a collection of black and white pixels, is encoded into n shadow images called shares, where each participant in P receives one share. Certain qualified subsets of P can visually recover the secret image by photocopying their shares onto transparencies and stacking them, but any forbidden set of participants have no information about the secret image. The novelty of visual cryptography lies in the fact that the encrypted message can be decrypted directly by the human visual system, no complex computation or computer participation is required. This is the precise reason of VCS attracting a lot of attention since its inception and as a result extensive research work has been carried out in this area. In this paper we shall deal with threshold secret sharing scheme, threshold secret sharing scheme with certain essential participants, monotone general access structures having information theoretic security.

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Spectral Homology and Cohomology Theories

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The aim of the lecture is to study homology and cohomology theories through the concept of spectra of spaces based on topology, which are called spectral homology and cohomology theories. If a homology (cohomology) theory satisfies only the first six of the seven axioms of Eilenberg and Steenrod announced in 1945 on a certain category, but first appeared in their celebrated book Foundations of Algebraic Topology in 1952, the corresponding homology (comology) theory is called a generalized homology (cohomology) theory. These theories are also discussed. K-theory is an outstanding example of generalized cohomology theory and it plays centrally a key role in connecting algebraic topology with algebra, analysis and algebraic geometry. Homology and cohomology groups are topological invariants like Euler characteristics and homotopy groups. Homology groups invented by Henry Poincare' in 1895 are in some sense, refinement of Euler characteristics. Cohomology is dual to homology and it arises from algebraic dualization of homology. There are only a few generalized cohomology theories. The problem: is it possible to construct a new generalized cohomology theory associated with a spectrum? This problem is solved in an affirmative way by using Dold-Thom theorem given by them in 1958. The motivation of the problem and method of solution are also explained.

In this lecture we define a new Ω-spectrum and construct its associated spectral cohomology theory. The motivation of this construction comes from Brown theorem given in 1962 which asserts that the singular ordinary cohomology groups of a

pointed finite CW-complex can be identified with the groups of homotopy classes of continuous maps into Eilenberg-MacLane spaces. Using this fact and homotopy properties of infinite symmetric product spaces, a new Ω-spectrum is constructed generalizing the Eilenberg-MacLane spectrum. The generalized cohomology theory associated with this new Ω-spectrum is constructed and is studied from the view point of homotopy theory. Moreover, certain close relations between this generalized cohomology theory and ordinary singular homology theory with integral coefficients are established.

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Optical-mechanical analogy and quantum trajectory

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Equation trajectory relativistic particles (in particular, quanta) received within the specific model of the dispersion relation between the energy and momentum. Revealed a complete analogy with the equations for classical particles (obtained from the variational principle of mechanics) and rays (derived from Fermat's principle).

We formulate the problem of further development of the tasks associated with a particular form of the potential energy of the quantum.

Recent studies of the evolution of perturbations of the charged interface of immiscible liquids [1-2] have shown that under certain conditions the dispersion relation can exist as a modulus of a linear function. Specific linear relationship between energy and momentum led to the idea of applying such an approach to the behavior of a quantum (photon), and applying an optical-mechanical analogy to this model, derive the equations of the quantum trajectory. In connection with the fact that the work is of a purely quasiclassical nature and quantumness exists only in the concept of the quantum itself, which appears in the context of the approximation of our problem as a particle, an analogy arises with the disassembled classical,

mechanical and optical problems, as well as imposing restrictions on the structure of the object under consideration, In this approximation it is sufficient to dispense with the concept of a trajectory without considering the uncertainty of the coordinate. It is interesting to note that in relativistic gravitational mechanics there is variational principle on which an analogy to geometrical optics or to classical mechanics can be constructed.

Оптико механическая аналогия и траектория кванта

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В рамках специфичной модели дисперсионной связи между энергией и импульсом получено уравнение траектории релятивистских частиц. Выявлена полная аналогия с уравнениями для классических частиц и лучей. Сформулирована проблема дальнейшего развития задачи, связанная с конкретизацией вида потенциальной энергии кванта.

Недавние исследования эволюции возмущений заряженной границы раздела несмешивающихся жидкостей [1-2] показали, что при определенных условиях дисперсионное соотношение может существовать как модуль линейной функции. Специфическая линейная зависимость между энергией и импульсом привела к идее применения такого подхода к поведению кванта (фотона) и применения оптико-механической аналогии к этой модели, выводящей уравнения квантовой траектории. В связи с тем, что работа носит чисто квазиклассический характер, а квантовость существует только в самом понятии самого кванта, которое появляется в контексте аппроксимации нашей задачи как частицы, аналогия возникает с разобранным классическим, механическим и оптических задач, а также наложение ограничений на структуру рассматриваемого объекта. В этом приближении достаточно обойтись без понятия неопределенности координаты с концепцией траектории. Интересно отметить, что в релятивистской гравитационной механике существует вариационный принцип, по которому можно построить аналогию с геометрической оптикой или с классической механикой.

Ontological-phase topological field theory: Einstein/Newton duality

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Newton claimed instantaneous gravity influence; Einstein insisted no influence propagates faster than c. Quantum Mechanics (QM) the so-called 'basement of reality', poses a search for Quantum Gravity, for which no *a priori* science exists. We propose additional dimensionality (XD) in an M-Theoretic Unified Field (UF) brane arena as the regime of integration which we describe with putative *a posteriori* surety, by an Ontological-Phase Topological Field Theory (OPTFT). This requires fundamental changes in the meaning of the concept of dimensionality. Following suggestions by Rowlands, two processes emerge for creating XD: 1) duality, with dimensions of a fundamentally different character, and 2) anticommutativity, where they are fundamentally the same. Yang-Mills Kaluza-Klein correspondence can drive Physics beyond the Standard Model (SM)? Horizontal and vertical subspaces in the tangent bundle of M ($M = X\,x\,G$) defined by Yang-Mills connections are orthogonal with respect to a Kaluza-Klein metric suggesting orthogonal extension to XD beyond the 4D limit of the SM. Major CERN LHC research seeks Kaluza-Klein XD beyond the SM. Current thinking posits XD as Planck-scale since they are not observed; however, this is not the only interpretation. A Large-Scale Additional Dimensional (LSXD) alternative is proposed with similarity to works of Arkani-Hamed and Randall-Sundrum. Albeit, our OPTFT iteration of M-Theory is based on radical extensions of the original hadronic form of string theory because of inherent key elements such as virtual tachyon/tardyon interactions and a variable concept of string tension, T_S. A and B type topological string theories, and a related Topological M-Theory with mirror symmetry, while interesting, since they allow sufficient dimensionality by Calabi-Yau mirror symmetry perceived essential for developing UFM; a distinction between these theories causes our model to diverge. A key parameter is topological charge in brane dynamics which by definition makes correspondence to a de-Broglie-Bohm super-quantum potential synonymous with an ontological 'Force of coherence', an inherent aspect of the UF. Thus UFM predicts no phenomenal graviton (perceived artifact of the incompleteness of Gauge Theory, i.e. Gauge Theory is approximate suggesting new physics). The difference between 4D quantum field phenomenology and LSXD topological field ontology is the 'energyless' exchange process. Information (Shannon related) is transferred ontologically by a process called 'topological switching' of the M-Theoretic brane dynamics carrying topological charge. Completing Geometrodynamics inherently includes Newton/ Einstein duality; evidenced we believe by interpreting quasar luminosity as gravitational shock waves countering Big Bang interpretations of large redshift, Z based on Doppler recession. Instead redshift would result from periodic

photon mass-anisotropy by coupling to a covariant polarized Dirac vacuum. A further conundrum exists by defining a Manifold of Uncertainty (MOU) of finite dimensional radius, allowing a wave-particle-like duality with a quantal-like virtual graviton in the 'semi-quantum limit' – an intermediary between field phenomenology and topological ontology. This has increasing importance for the new field of Relativistic Information Processing (RIP) which introduces gravitational effects in the 'parallel transport' of topological switching in branes. From the broad context introduced above the central theme of this paper is the introduction of a topological formalism for a new set of UF transformations beyond the Galilean, Lorentz-Poincairé. An empirical protocol falsifying the model is developed; which if successful could have far reaching consequences for experimentally validating XD, M-Theory and provide table-top low energy UFM 'cross section' alternatives for 'viewing' putative SUSY partners in a trans-dimensional 'slice' rather than the usual TeV to PeV supercollider collision techniques producing the standard cross section particle sprays in the successful 100-year history of high energy collision physics. This is a seminal introduction to a paradigm shift (OPTFT) and thus fraught with a plethora of detail.

Semiology of Linguistics and Geometric Lie Algebra Foundation of Atomic Structure and Periodic System

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Starting from the semiology (i.e., the logic and physics of culture) of linguistics in terms of an extension of a correlation of the usual 26 English alphabets with the corresponding numbers, (a=1, b=2, …, z=26) by attaching the numbers to the alphabets so as to form a cube-hexagon/torus step pyramid, we show that this methodology permits corresponding Sanskrit/Devanagari alphabets to be arranged in a 6x6 magic square matrix of numbers 1,2,…,36 correlated with gravitational lensing and arranged geometrically in a similar cube-hexagon/torus step pyramid. The linguistic/structural view that emerges is shown to be very much in line with Mendeleev original moulding of his two-dimensional rendering of the periodic table on the dual Sanskrit grammar/phonetics, and leads to a striking Lie geometric/structural correspondence with observed atomic structure and periodic system of elements. The implications for digital signal processing with computers is discussed.

The relativistic inertial coordinate reference frames, synchronized the observed radio emission of pulsar

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The paper focuses on the study of physical compatibility and metric consistency of relativistic coordinate reference frames, both dynamic and kinematic, i.e inertial ones, in accordance with the astrometric observations of pulsars. It have been comparing the ephemeris time scales obtained by numerical solution of dynamic equations of motion of celestial bodies, and physical pulsar time scales obtained by the parametric approximation of the measured intervals of the observed periodic radio emission from of galactic sources - pulsars. It is shown the forminvariant of physical equations of the pulsar events intervals *PTobs* observed in the local topocentric and barycentric coordinates, whose solution are the observed rotation parameters of pulsar. It is established the numerical equivalence intervals *PTcalc* denominated analytically in terms of observed rotation parameters P, $\dot{P}$, $\ddot{P}$, which are numerically the same to the coinciding epoch of topocentric and barycentric coordinate time.

Analytical coordinate-independent pulsar time scales *PTcalc* extend with the same observed rotation parameters to any topocentric coordinates system with the centre specified by local geodetic coordinates on the geoid. This proves that the periodic emission of galactic source pulsar specifies the physical time at any point of the Solar System, which is determined by the form-invariant equations and localize as the time scales in any inertial Galilean coordinate system, which owns this point. All coordinate systems are equal. In each of them there is a single physical time *PTcalc*, lines of which are orthogonal to the three-dimensional space, and the time scale corresponds to the same conditions of observation of celestial bodies motion and, as a consequence, the simultaneity of events for all points of the three-dimensional space.

Extension of physical pulsar time scales into inertial coordinate system confirms, firstly, the homogeneity of time, meaning the same flowing of physical phenomena (in the same conditions) at different epochs of their observation and, as a consequence, the implementation of the energy conservation law. Secondly, it confirms isotropy of space, meaning the same properties of space at every point in all directions: physical processes are not changed by rotating the coordinate axes at any angle in space and, consequently, the carrying out of the law of conservation of angular momentum (and actually pulsar including those).

For example, the barycentric TB (TDB) and topocentric TT coordinate pulsar time scales, synthesized from the observed rotation parameters of the pulsar J1509 + 5531 on the radio telescope BSA FIAN in Pushchino, reach of machine accuracy and subnanosecond resolution of the intervals, which are the same in any coordinate system for coinciding epochs of local coordinate time. The relative instability of pulsar scales, which are defined by the coherence periodic radio emission of pulsar,

does not exceed 10^{-20} - 10^{-21} during already almost 50-year observations of pulsars after their opening in 1967.

Models of the open Universe as analogues of multidimensional electric capacitors

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The finding problem of cosmological models of the open Universe is based on solutions of the Einstein gravitational equations as usual with specific equations of state (another approach can be seen in [1-2]).

In this research there is an attempt to consider these cosmological models on the other hand as an analogy with electrostatics of conductors. The conductors create a multidimensional system which can be further named as the multidimensional electric capacitor or k- capacitor.

At first the 4D space-time with a metric conformal to the Minkowski metric is taken. The metric depends from a variable S only ($S^2 = t^2 - r^2$; t, r are time and radial variables, the velocity of light is taken equal to unit). The Einstein equations without cosmological term and with a source in form of the energy-momentum tensor in an approximation of the perfect Pascal fluid are written with a linear equation of state $p = \beta\varepsilon$, where ε is an energy density; p is a pressure; $\beta = const$; $|\beta| < 1$.

The gravitational equations with such equation of state can be transformed into equation of Laplace for multidimensional Euclidian space of variable S for spherical case. Physical limitation on a discrete spectrum of the constant values β sets a limit and on of a discrete spectrum of dimensionality k of Euclidean spaces.

Additionally, the problem of finding cosmological solutions for the open Universe can be replaced by a similar task of minimization of the functional energy of electrostatic distribution in Euclidean multidimensional space.

The discovered analogy between open cosmological models in 4-dimensional space-time and "spherical" electrical condensers in multidimensional Euclidean spaces of dimensionality $k = 1,2,3 \ldots ,6$ shows a possibility of replacement of a cosmological problem by equivalent electrostatic problem for finding electric capacitance at the given boundary conditions.

There are a few examples. In particular, the cosmological solution of Friedman open Universe with $\beta = 0$ (incoherent dust) corresponds to the spherical capacitor in the auxiliary Euclidean space of dimension $k = 3$. The capacity of this capacitor is connected with the conformal factor of the Friedman solution.

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Модели открытой Вселенной как аналоги многомерных электроемкостей

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Нахождение космологических моделей открытых Вселенных, отвечающих различным физическим состояниям, основано, как правило, на решении уравнений тяготения с конкретными уравнениями состояния (другой подход можно увидеть в [1-2]).

В настоящем исследовании делается попытка взглянуть на эти модели несколько с иной стороны, проведя аналогию с электростатикой проводников, образующих многомерную систему, называемую в дальнейшем многомерным конденсатором или -конденсатором.

Сначала берется 4D пространство-время с метрикой, конформной метрике Минковского и зависящей только от переменной S ($S^2 = t^2 - r^2$, t, r суть временная и радиальная переменные, скорость света выбрана равной единице). Уравнения Эйнштейна без космологического члена и с источником в виде тензора энергии-импульса идеальной паскалевой жидкости записываются при наличии линейного уравнения состояния $p = \beta\varepsilon$, где ε – плотность энергии; p – давление; $\beta = const$; $|\beta| < 1$.

Уравнения тяготения с таким уравнением состояния могут быть преобразованы в уравнение Лапласа для многомерного евклидового пространства переменной S в сферически симметричном случае. Физические ограничения на дискретный спектр постоянной β ограничивают и дискретный спектр размерности k евклидового пространства.

Оказывается, что задача по нахождению открытых космологических решений может быть заменена рассмотрением вариационной задачи, аналогичной задаче по минимизации функционала энергии электростатического распределения потенциалов в многомерном евклидовом пространстве.

Обнаруженная аналогия между открытыми космологическими моделями 4D пространстве-времени и “сферическими” электрическими конденсаторами в многомерных евклидовых пространствах размерности показывает возможность замены космологической задачи на эквивалентную электростатическую по нахождению электроемкости при заданных граничных условиях.

Приводится ряд примеров. В частности, космологическое решение Фридмана для открытой Вселенной при $\beta = 0$ (некогентная пыль) отвечает сферическому конденсатору во вспомогательном евклидовом пространстве размерности $k = 3$. Емкость этого конденсатора связана с конформным множителем решения Фридмана.

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Vaidya Collapse with Nonzero Radial Pressure

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The cosmic censorship hypothesis [1] is regarded as one of the most important unsolved problems in classical general relativity theory. If we look at a typical star and ask what happens after it has exhausted its nuclear fuel, there are three possibilities, depending upon the mass of the star. The first two possibilities are, in order of increasing starting mass, a white dwarf or a neutron star. However, if the star is massive enough (typically of the order of about 10 solar masses or so, depending upon whether it rotates or not), after it has exhausted its nuclear fuel, there is nothing to halt the collapse process. According to the Hawking-Penrose singularity theorems [2], it will end up in a singularity. However, these theorems do not give information about the nature of this singularity itself.

According to the cosmic censorship hypothesis, the singularity will be a black hole, covered by an event horizon. Despite much investigation, as yet, there is no proof of the hypothesis. However, there is another possibility, and that is that naked singularities can form, which can in principle, be observed by a distant observer. Nowadays, there are numerous examples where the hypothesis is violated, although there is still no agreement if these are physically realistic or not [3-4 and references

therein]. One of the first examples that was studied to exhibit a naked singularity is the Vaidya solution [5], which represents a spherically symmetric body consisting of null dust that is radiating (or collapsing). The metric is given by

$$ds^2 = -\left[1 - \frac{2m(v)}{r}\right] dv^2 + 2dvdr + r^2 d\Omega^2$$

where v is the advanced ingoing time coordinate, r is the usual radial coordinate and $d\Omega^2$ represents the metric of the unit two-sphere. Dwivedi and Joshi [6] have given a good treatment of the occurrence of the naked singularity for this spacetime.

One of the criticisms that has been levelled against the Vaidya metric is that it consists of null dust which has no pressure. In a realistic gravitational collapse scenario, we expect there to be pressure. Recently, an interesting generalization of the Vaidya spacetime has been given [7] which incorporates nonzero radial pressure:

$$ds^2 = -\left[1 - \frac{2m(v)}{r}\ e^{-\frac{2m(v)}{er}}\right] dv^2 + 2dvdr + r^2 d\Omega^2$$

The question that arises is whether the introduction of pressure can help to avoid the naked singularity and hence restore the validity of the cosmic censorship hypothesis. In this work, the gravitational collapse of this configuration is studied, to see if the hypothesis is still violated. By assuming some reasonable forms for $m(v)$, and studying analytically the geodesics of the spacetime following the methods as espoused in [8], we find that both black holes and naked singularities can form, depending upon fairly general initial conditions.

This it appears that the introduction of pressure is not sufficient to halt the occurrence of naked singularities in the Vaidya spacetime.

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Phenomenology of cosmological particle creation, Dirac sea and all that

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Here we present a phenomenological model of cosmological particle creation which allows to avoid the "vicious circle" when the purely quantum treatment of the fields, which quanta are just the created particle, requires imposing definite boundary conditions, while the latter, in turn, requires solving the gravitational equations with the created particles together with the expectation values of these very fields as their source.

We are using the hydrodynamical description of the created particles (in Eulerian coordinates) incorporating the "creation law" straight into the action integral with the corresponding Lagrange multiplier. Adopting the famous result that the particle production rate is proportional to the square of the Weyl tensor, we showed that this induces the appearance of conformal gravity action integral. Namely, the total actions, with and without Weyl gravity term, differ by some surface integral. It was tempting, then, to demand the local conformal invariance as the fundamental law. Such a requirement, as was shown, has very far-going consequences.

It concerns, first of all, the scalar field (terribly needed in the Standard Model). We should note that due to the phenomenological character of our model, the scalar field is already present as the created particles (= real quanta) and as the square of the Weyl tensor (= part of the conformal anomaly responsible for particle production).

We are left with some residual ("vacuum") part of the conventional fundamental scalar field. If one puts it zero, then the result would be simply the pure conformal gravity - without the Einstein-Hilbert action integral and with no chance to get massive particles through, say, the Brout-Englert-Higgs mechanism. therefore, we are forced to consider the nonvanishing residual scalar field. Writing for it the simplest possible action (kinetic + mass terms only) we showed that the local conformal invariance requires introduction of the curvature scalar and, at the same time, the identification of this field with one of the possible conformal factors, and such an identification induces the self-interaction arising from the mass term and playing the role of the quintessence.

Thus, we have got the Weyl-Einstein-dilaton gravity with the cosmological term almost for nothing. The necessity for the identification comes from the very simple question: If the local conformal invariance is really the fundamental physical law (and not just the mathematical exercise), then, how the scalar field, being an independent dynamical variable, could know about the surgery undergone by the metric tensor?

Then, we considered the vacuum equations in our model. In the case of the “empty vacuum” (i.e., no particles and no particle creation) the square of the Weyl tensor must be zero. If the vacuum state is spherically symmetric, the Weyl tensor itself is zero as well. The only solutions are de Sitter and anti-de Sitter space-times. If the cosmological constant is negative, the effective potential for the scalar field is exactly the Higgs potential, and anti-de Sitter solution corresponds to its minimum which is stable. But, when the cosmological constant is positive, the effective potential should be turned upside-down, and we are in its maximum which is unstable.

It can be checked that there are no more vacuum solutions, conformal to this de Sitter space-time. This means that the universe born in the vacuum de Sitter state, starts immediately filling with the matter.

There is yet another possibility - the “dynamical vacuum”, when particle with both positive and negative energies are continuously creating leaving the total energy-momentum tensor zero. This is just the Dirac sea. The vacuum equations in this case are especially nice - the linear combination of the Bach tensor, the Einstein tensor and the cosmological constant. The structure of the space of the solutions is now a much more rich.

We can say definitely that they are by no means homogeneous and isotropic. This deserves further investigation.

Феноменология космологического рождения частиц, море Дирака и всё такое прочее

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Мы представляем феноменологическую модель космологического рождения частиц, которая позволяет избежать “замкнутый круг”, когда чисто квантовое описание полей, квантами которых являются рожденные частицы, требует наложения специальных граничных условий, которые, в свою очередь, требуют решения гравитационных уравнений с рождающимися частицами совместно с ожидаемыми значениями самих квантовых полей в качестве источников.

Мы используем гидродинамическое описание для рожденных частиц (в Эйлеровых координатах), включая “закон рождения” непосредственно в интеграл действия с соответствующим множителем Лагранжа. Используя знаменитый результат о скорости рождения частиц, пропорциональной квадрату тензора Вейля, мы показываем, что в результате появляется интеграл действия конформной гравитации. А именно, полное действие с вейлевским гравитационным членом и без него отличаются некоторым поверхностным

интегралом. Это позволяет постулировать локальную конформную инвариантность в качестве фундаментального закона. Оказывается, что такое требование имеет далеко идущие следствия. Во-первых, это касается скалярного поля, которое постулируется в Стандартной Модели. Отметим, что скалярное поле уже содержится в нашей феноменологической модели в виде рожденных частиц (являющихся реальными квантами поля), а также в качестве квадрата тензора Вейля, являющегося частью конформной аномалии, ответственной за генерацию частиц.

У нас остается некоторая остаточная (вакуумная) часть фундаментального скалярного поля. Если ее положить равной нуля, то останется чисто конформная гравитация без интеграла действия Эйнштейна-Гильберта и, соответственно, без всякого шанса генерации массивных частиц по механизму Браута-Энглера-Хиггса. По этой причине мы рассматриваем ненулевое остаточное поле, записывая для него простейшее действие (только с кинетическим и массовым членом). Мы показываем, что локальная конформная симметрия требует введения кривизны скалярного поля и, одновременно, идентификации этого поля с одним из возможных конформных факторов. Такая идентификация индуцирует самодействие, возникающее из-за наличия массового члена у скалярного поля, которое выполняет роль квинтэссенции.

В результате мы получаем модель гравитации Вейля-Эйнштейна с дилатоном, в которой имитируется космологическая постоянная. Необходимость проведенной идентификации проистекает из очень простого требования. А именно, постулирование конформной инвариантности в виде фундаментального физического закона (а не только лишь математического упражнения) требует наличия специфической связи скалярного поля с метрическим тензором.

Мы исследуем вакуумные уравнения построенной модели. В случае “пустого вакуума” (т.е., состояния без частиц и без их рождения) квадрат тензора Вейля обязан быть равным нулю. Если вакуумное состояние сферически симметрично, то тензор Вейля сам по себе равен нулю. Единственными решениями оказываются геометрии де Ситтера и анти-де Ситтера. Если космологическая постоянная отрицательна, то эффективный потенциал скалярного поля есть в точности потенциал Хиггса, и решение анти-де Ситтера соответствующее минимуму потенциала, является стабильным. Однако при положительной космологической постоянной эффективный потенциал опрокидывается и решение, которое соответствует максимуму потенциала, будет неустойчивым. Было показано, что нет других вакуумных решений, конформных пространству-времени де Ситтера. Это означает, что вселенная, рожденная в состоянии вакуума де Ситтера из-за своей неустойчивости немедленно начнет наполняться веществом. Есть еще другая возможность – это “динамический вакуум”, когда непрерывно рождаются частицы с положительными и отрицательными энергиями, оставляя тензор энергии-импульса равным нулю. Этот случай как раз соответствует морю Дирака. Вакуумные уравнения в этом случае особенно изящны: это линейная комбинация тензора Баха, тензора Эйнштейна и космологической постоянной.

Структура пространства решений таких уравнений намного богаче, чем в случае “пустого вакуума”. Эти решения могут быть однородными и изотропными и заслуживают дальнейшего исследования.

Inflation, superstrings and hidden time-like dimensions

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It is known that to describe the cosmological inflation, it is necessary to obtain the vacuum solution representing the four-dimensional space-time in the form of a space of constant positive curvature which is most simply described by a Robertson-Walker metric having the scale factor with exponential time dependence. In standard general relativity, this solution is obtained by introduction of the cosmological constant Λ associated with dark energy, whose nature is still not clear. At that four-dimensional space-time having constant positive curvature can be obtained only if the cosmological constant has a positive value. It turned out that in the low-energy limit of superstring theory it is impossible to obtain such solution due to so-called no-go theorem and the positive cosmological constant corresponding to observational data cannot be obtained. In the superstring theory this problem can be solved taking into account quantum gravity corrections that include terms of higher order in the curvature tensor. Then positive cosmological constant naturally arises and cosmological solution describing inflation can be obtained. At that, for the extra dimensions to be unobservable, it is necessary that the internal space radius be of the order of the Planck length. However, in the superstring theory with the standard signature one gets the following. If extra space dimensions are of Planck order then the cosmological constant that is obtained using quantum gravity corrections is 122 orders of magnitude larger than the observed value. Therefore it is natural to take the point of view that the signature of space-time should be determined dynamically. The method consists in the following. Initially, arbitrary signatures are considered and then it is determined what signatures allow the existence of cosmological type solutions satisfying the specified conditions. We aimed to investigate the effective field theory of type II A superstrings with quantum gravity corrections taken into account allowing arbitrary signatures of space-time. Equations of motion describing the gravitational field interacting with the dilaton and the Calb-Ramond field was investigated. Cosmological solution describing inflation of Universe by according to the Hubble’s law and cosmological constant corresponding to observational data were obtained. Thus it was shown that the cosmological constant problem may be solved using hypothesis of additional time-like dimensions. It can also be hope that the investigation could shed light on the dark energy nature.

Wormholes, “trapped ghosts” and the stability problem

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A brief review is given to the properties of static, spherically symmetric configurations of general relativity with a minimally coupled scalar field whose kinetic energy is negative in a restricted (strong-field) region of space and positive outside it [1-3]. This “trapped ghost” concept may in principle explain why no ghosts are observed under usual, weak-field conditions. The configurations considered are wormholes and regular black holes without a center, in particular, black universes (black holes with an expanding cosmology beyond the event horizon) [4-6]. Spherically symmetric perturbations of these objects are considered, and it is stressed that, due to the universal shape of the effective potential near a transition surface from canonical to phantom behavior of the scalar field, such transition surfaces restrict the possible perturbations and play a stabilizing role.

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Principle of Causality, Non-Anthropogenous Forecasting and Superluminal Velocity of Propagation of a Signal

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The article is devoted to the issue of superluminal (or negative) group velocity of signals in the dispersing medium, and also about negative group delays of signals while passing through linear filters. It is shown that the velocity of propagation of information in any medium accurately coincides with vacuum velocity of light, but group velocity isn't the velocity of propagation of information and therefore can be superluminal or negative without violation of “light restriction” in the relativity theory and the principle of causality.

The question is that not only phase, but also wave group velocity basically is not data transmission velocity and therefore "light restriction" of the special relativity theory is not applied only to phase, but also to group velocity. In terms of phase velocity - its “ability” to be superlight without contradiction with the relativity theory was recognized long ago; group speed is still often incorrectly identified with the velocity of signal propagation as a data carrier, which is theoretically absolutely incorrect, as group velocity is displacement velocity of a differentiable signal envelope, and the signal envelope does not basically transmit data.

In order to understand the essence of this statement it should be recalled that in complex variable function there exists theorem of uniqueness of analytical function that affirms that two analytical functions concurrent on some limited section of real axis, are concurrent on the whole real axis. Analytical function in particular, which is zero identical on some limited part of real axis, is zero identical on the whole real axis.

In this case it means that signal $E(z,t)$, which is analytical function of real variable t and is not zero identical, cannot become zero in any limited section of real axis t - in particular, it cannot meet the requirements of $E(z,t) = 0$ where $t < t_0$. It shows that such signal is exists forever (in case $-\infty < t < +\infty$) and cannot be used for data transmission in theory. Actually in any space point z and at any specific time t a part of signal, defined at all previous time points, is traceable. In accordance with the above-mentioned theorem of analytical function uniqueness the time dependency of signal part can be fully recovered at any preceding or succeeding time point. Therefore, no signal, used for data transmission, cannot be analytical function on the whole real axis t; it can be concurrent with some analytical function only in case when $t \geq t_0$, where t_0 - the moment of signal origin.

The point t_0 is a fault point of its analytic property, that is usually reflected as discontinuity of its time dependence of the signal and (or) its variables. These are signal discontinuity and its variables that transmit data, as, in fact, time dependence of the signal between any two discontinuity points can be fully recovered by its

variables in the discontinuity point (analytical continuation with the help of power series) without real signal indication in the indication point. The issue of displacement velocity of electromagnetic signal discontinuity or its variables is considered in depth. The fundamental result of the conducted study is the conclusion that these discontinuities in any circumference precisely transfer at a rate of knots in vacuum – nothing more nor less, moreover the amplitude of discontinuity during signal propagation doesn't change (even in absorbing medium) in one-dimensional problem.

The mechanism of superlight group velocities origin (as well as negative signal delay times) is discussed. It is shown that this mechanism is related to non-anthropogenic (without direct participation of a man) forecasting gradual time dependence of the signal in the future. The non-anthropogenic forecasting is carried out in the same way as anthropogenic (consciously man-made) forecasting of time dependence function in the real time period - by way of summing up (two in case of linear extrapolation to unlimited quantity when convolution integral is used) differently delayed copies of some part of signal with properly fitted coefficients. It is clear that there are infinitely many ways of forecasting as well as point and continual extrapolation formulas.

Принцип причинности, неантропогенное прогнозирование и сверхсветовая скорость распространения сигнала

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Обсуждается вопрос о сверхсветовых (или отрицательных) групповых скоростях сигналов в диспергирующих средах, а также об отрицательных временах групповой задержки сигналов при прохождении через линейные фильтры. Показано, что скорость распространения информации в любой среде в точности совпадает с вакуумной скоростью света, но групповая скорость не является скоростью распространения информации и потому может быть сверхсветовой или отрицательной без нарушения "светового ограничения" теории относительности или принципа причинности.

Дело в том, что не только фазовая, но и групповая скорость волны, строго говоря, не является скоростью передачи информации и потому "световое ограничение" специальной теории относительности не распространяется не только на фазовую, но и на групповую скорость. Если говорить о фазовой скорости, то ее "право" быть сверхсветовой без противоречия с теорией относительности давно признано; групповую же скорость до сих пор часто ошибочно отождествляют со скоростью распространения сигнала в смысле переносчика информации, что, строго говоря, совершенно неверно, поскольку

групповая скорость является скоростью перемещения гладкой огибающей сигнала, а гладкая огибающая, строго говоря, информацию не переносит.

Для понимания смысла этого утверждения необходимо напомнить, что в теории функций комплексного переменного существует теорема о единственности аналитической функции, утверждающая, что две аналитические функции, совпадающие на некотором конечном отрезке вещественной оси, совпадают на всей вещественной оси. В частности, аналитическая функция, тождественно равная нулю на некотором отрезке вещественной оси, есть тождественный ноль на всей вещественной оси.

В нашем случае это означает, что сигнал $E(z,t)$, являющийся аналитической функцией вещественной переменной t и не являющийся при этом тождественным нулем, не может обращаться в 0 ни на одном конечном отрезке вещественной оси t – в частности, он не может удовлетворять условию $E(z,t) = 0$ при $t < t_0$. Это означает, что такой сигнал существовал, существует и будет существовать всегда (при $-\infty < t < +\infty$) и в принципе не может использоваться для передачи информации.

Действительно, в любой точке пространства z в любой момент времени t уже доступна для анализа часть сигнала, принятая во все предыдущие моменты времени. По этой части сигнала в соответствии с упомянутой выше теоремой о единственности аналитической функции в принципе может быть полностью восстановлена его временная зависимость в любой предыдущий или последующий момент времени. Поэтому ни один сигнал, использующийся для передачи информации, не может являться аналитической функцией на всей вещественной оси t; он может совпадать с некоторой аналитической функцией лишь при $t \geq t_0$, где t_0 - момент возникновения сигнала.

Точка t_0 при этом является точкой нарушения его аналитичности, что обычно проявляется как разрыв временной зависимости самого сигнала и (или) его производных. Именно разрывы сигнала и его производных переносят информацию, потому что в принципе временная зависимость сигнала между любыми двумя точками разрыва может быть полностью восстановлена по его производным в точке разрыва (аналитическое продолжение с помощью степенных рядов) без реального приема этого сигнала в точке приема. Подробно рассмотрен вопрос о скорости перемещения разрывов электромагнитного сигнала или его производных. Основным результатом проведенного рассмотрения является вывод о том, что эти разрывы в абсолютно любой среде перемещаются в точности со скоростью света в вакууме – не больше (и не меньше!), причем в одномерной задаче амплитуда соответствующего разрыва при распространении сигнала не изменяется (даже в поглощающей среде).

Обсужден механизм возникновения сверхсветовых групповых скоростей (равно как и отрицательных времен задержки сигнала). Показано, что этот механизм сводится к неантропогенному (без сознательного участия человека) прогнозированию плавной временной зависимости сигнала в будущее. Само же это неантропогенное прогнозирование осуществляется точно так же, как антропогенное (сознательно осуществляемое человеком) прогнозирование

временной зависимости функции в режиме реального времени – путем суммирования нескольких (от двух в случае линейной экстраполяции до бесконечного количества в случае использования интеграла свертки) по-разному задержанных копий принятой части сигнала с соответствующим образом подобранными коэффициентами. Ясно, что способов такого прогнозирования существует бесконечно много - столько же, сколько существует формул точечной или континуальной экстраполяции

Heat contributes to dynamics of Einstein-Infeld fields

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In 1938 Einstein and Infeld oriented Special Relativity (SR), General Relativity (GR), and Classical Electrodynamics on the nondual concept of pure fields where the density of the elementary particle is not a peculiarity (Dirac delta-function) but a continuous material distribution over the entire Universe. Such an extended elementary carrier of energy may have chaotic internal motion of material densities, related to carrier's relativistic heat or the rest mass energy mc2. An ordered motion of these densities, associated to spatial translations of the elementary carrier, decreases the chaotic kinetic energy. Under the geodesic motion of the real probe body, its chaotic and ordered kinetic energies tend to the equilibrium equipartition. This tendency to the kinetic energy equipartition, rather to the minimum of the potential energy, reveals the new target for mutual attraction of gravitating partners. Variations of internal heat can vary geodesic paths of free thermodynamic bodies like asteroids, comets, and planets. Einstein's dynamics of full energy charges quantitatively incorporates variable heat of thermodynamic bodies into the relativistic laws of mechanical motions. Therefore, Newtonian model of masses without temperature cannot be a true nonrelativistic limit for SR/GR references. Due to the kinematic loss of heat under spatial motion, the SR/GR kinetic energy of slow translations should double the classical value $\frac{mv^2}{2}$ in order to keep true summary changes of bound energies for internal and external motions. Newton was not aware of the internal heat energy and the 1908 Laue law for its translation. This lack of knowledge maintains the known metaphysical position: "Einstein's theory can be accepted only with the recognition that Newton's was wrong." (S. Kuhn. The Structure of Scientific Revolutions, 1962, p.98). SR/GR textbooks and advanced teaching of relativistic physics should unify thermodynamics and gravito-mechanics in the 1938 pure field terms of Einstein-Infeld nondual physics.

Weakness of gravity as the illusion hiding a true way to physics of elementary particles

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Modern crisis in quantum gravity is caused by the belief that Gravity is weak and its role is negligible in particle physics. Indeed, it is illusion, reason of which is the analysis of gravitational influence on the metric, based on the masses of particles and Schwarzschild solution.

Meanwhile, elementary particles have ultra-high spin which exceeds their mass about 22 orders (in dimensionless units $c = \hbar = G = 1$). Spin of particles acts on the metric as the known frame-dragging (invariant Lense-Thiring effect). Similar to role of Gravity in Universe, where nobody can say that Gravity is weak, the huge spin of elementary particles creates strong deformation of space by changing its topology in the Compton zone and does the space absolutely inappropriate for the work of quantum theory. The Kerr-Newman (KN) solution with parameters of an electron shows that huge spin of the electron shifts the known conflict between Gravity and Quantum theory from Planck to the Compton scale, where the KN Gravity becomes strong and begins interact with Quantum theory on an equal footing.

A way out of the conflict gives SUPERSYMMETRY. We consider a Super-Bag - nonperturbative bag-like solution in the supersymmetric Higgs model of symmetry breaking. Higgs model is often used for solitons, dual string models and bag models. It is well known also as the Landau-Ginzburg (LG) field model for superconducting media, where the solitons, strings and bags are formed as cavities in a superconducting vacuum. Supersymmetry allows to form a Super-Bag model with new features: a superconducting bag which expels electromagnetic (EM) field from the core of bag, and one more remarkable feature – the internal supersymmetric vacuum state expels also gravitational field from the core,leaving intact the external KN gravitational field. Using supersymmetric LG field model, we obtain nonperturbative Super-Bag solution for electron which expels KN gravity from Compton zone inside the bag, creating the free from Gravity flat space, which is absolutely necessary for normal work of Quantum theory.

Basic features of the bags are their relationships to string models. KN gravity defines shape of the electron as a thin superconducting disk with a circular string placed along its perimeter. Traveling waves along this string are related with excitations of the Kerr geometry and create a circulating singular pole playing the role of a quark, or a naked electron in the state of zitterbewegung. While the consistent with KN gravity dressed electron forms a “bag-string-quark” system.

We show that super-Bag model is naturally upgraded to the Wess-Zumino model of Supersymmetric QED, which provides the link to perturbative properties of the conventional QED.

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Слабость гравитации как иллюзия, скрывающая истинный путь к физике элементарных частиц

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Современный кризис в квантовой гравитации связан с иллюзией, что гравитация является слабой и ее роль в физике элементарных частиц незначительна. Эта иллюзия основана на анализе гравитационного влияния массы частиц на метрику пространства-времени решении Шварцшильда.

Между тем, элементарные частицы имеют гигантский спин, который превышает их массу приблизительно на 22 порядка (в безразмерных единицах $c = \hbar = G = 1$). Спин частиц действует на метрику как известное увлечение систем отсчета (frame-dragging, или эффект Лензе-Тирринга).

Подобно роли Гравитации во Вселенной, где никто не может сказать, что Гравитация слаба, огромный спин элементарных частиц создает сильную деформацию пространства, изменяя его топологию в зоне Комптоновских расстояний, делая пространство абсолютно непригодным для работы квантовой теории. Решение Керра-Ньюмена (КН), соответствующее параметрам электрона, показывает, что связанный со спином острый конфликт между Гравитацией и Квантовой теорией перемещается с Планковского масштаба к масштабу Комптона, где сильное взаимодействие Гравитации с Квантовой теорией проходит “на равных” условиях.

Выход из конфликта дает СУПЕРСИММЕТРИЯ. Мы рассматриваем непертурбативное решение для спинирующего “мешка” в модели Хиггса с нарушенной симметрией, которая часто используется для моделей солитонов, дуальных моделей струн и моделей мешков. Она известна также как модель сверхпроводимости Ландау-Гинзбурга (ЛГ), в которой солитоны, струны и сумки формируются как ямы в сверхпроводящем вакууме. Суперсимметрия позволяет сформировать модель Супер-Мешка, как сверхпроводящий солитон, в котором сверхпроводимость выталкивает электромагнитное (ЭМ) поле из мешка. Однако суперсимметрия дает еще одну замечательную особенность - суперимметричный вакуум изгоняет как ЭМ так и гравитационное поле.

Суперсимметричная модель ЛГ, описывает супер-мешок, который выгоняет наружу поле КН, формируя внутри свободное от гравитации плоское пространство для нормальной работы квантовой теории.

Одной из особенностей мешков является связь с моделями струн. Гравитация КН определяет форму электрона - Супер-Мешка в виде тонкого диска с кольцевой струной на его краю. ЭМ возбуждение геометрии КН порождает бегущую вдоль струны волну и сингулярный узел, играющий роль кварка (голого электрона), осциллирующего на струне (zitterbewegung). Так, что соответствующий одетый электрон образует систему “мешок-струна-кварк”. Модель подразумевают согласованное решение уравнений Дирака. Мы показываем, что модель Супер-мешка обобщается естественным образом до модели Супер-КЭД (Весса-Зумино), что дает связь модели электрона-Супер-Мешка с пертурбативным формализмом традиционной КЭД.

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Cosmology induced from modified gravity

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The renaissance of modified theories of gravity and active study of them has been started with the discovery of acceleration in Universe expansion at present time. Further development has got the Multi-Scalar-Tensor (MST) theory, Einstein-Gauss-Bonnet (EGB) and f(R)-gravity. All this progress is reflected in cosmological models. According to generalization of Einstein equations, the cosmological equations in Friedmann universe became different and later inflation may be included by natural geometric manner.

In the present talk the cosmological models based on MST theory of gravitation will be compared with the Chiral Cosmological Models (CCMs) in General Relativity. It will be shown that by adding the scalar field as the source of MST gravitation it is possible to describe early universe and inflation in the slow roll regime. Also it will be discussed how to generate new solutions in MST on the basis of CCM solutions in GR.

Exact cosmological solutions in EGB gravity in 5D spacetime will be presented in the models where the chiral cosmological fields is the source of gravitation. Exact solutions for cosmology based on f(R) gravity with a scalar field will be presented as well.

Космология, индуцированная модифицированной гравитацией

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Возрождение модифицированных теорий гравитации и их активное изучение началось с открытия ускорения в расширении Вселенной в настоящее время. Дальнейшее развитие получили теория Мульти-Скалярно-Тензорной (МСТ) гравитации, Эйнштейна-Гаусса-Бонне (ЭГБ) и f(R) -гравитации. Все эти достижения отражены в космологических моделях. В соответствии с обобщенными уравнениями Эйнштейна, космологические уравнения во Вселенной Фридмана изменяются, и поздняя инфляция может быть включена в теорию естественным, геометрическим образом.

В настоящем докладе космологические модели, основанные на МСТ теории гравитации, будут сопоставлены с киральными космологическими моделями (ККМ) в Общей теории относительности. Будет показано, что, рассматривая скалярное поле в качестве источника гравитации МСТ, можно описать раннюю Вселенную и инфляцию в режиме медленного скатывания. Также будут обсуждаться вопросы генерирования новых решений в МСТ на основе решений ККМ в ОТО.

Точные космологические решения в гравитации ЭГБ в 5-мерном пространстве-времени будут представлены в моделях с киральными космологическими полями в качестве источника гравитации. Также будут представлены точные решения для космологии, основанной на f(R) гравитации со скалярным полем.

Understanding General Relativity after 100 years: a novel perspective

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General relativity is in many ways unique and different from all other physical theories. The first and foremost among them is the fact that gravitational law is not prescribed but is dictated by spacetime curvature. In absence of all forces, space is homogeneous and isotropic, and time is homogeneous. Since location in space as well as in time does not matter, space and time must be related through a universally invariant velocity, c.

Thus we have homogeneous spacetime (space being homogeneous and isotropic and time homogeneous), what should be its geometry. It should also be homogeneous which means Riemann curvature must be homogeneous. It must be covariantly constant. Thus force-free state of spacetime is not of zero curvature – flat but instead it is of constant curvature. This is how an invariant length arises as constant curvature of free spacetime – the so called cosmological constant (CC).

This is how the two most fundamental constants in c and CC arise as part of the spacetime structure. No other constant can claim this degree of fundamentalness.

What happens when spacetime is inhomogeneous? Then naturally arises the Einstein gravity (GR) through the Bianchi identity. It is remarkable that inhomogeneity of spacetime dictates Einstein gravity. In absence of gravity, spacetime is homogeneous and presence of gravity makes it inhomogeneous – a natural transition from homogeneity (no force) to inhomogeneity (universal force – gravity).

In GR, self interaction or gravitational field energy does not gravitate through a stress tensor as we write no stress tensor for it on the right of the equation. It is because it is a secondary source which caused by gravity itself and hence has no independent existence. This points to a general principle that a secondary source must not gravitate through a stress tensor but by enlargement of the framework. For GR, it was curvature of space that accounted for self interaction.

Similarly how should vacuum energy produced by quantum fluctuations of vacuum gravitate? Obviously not by a stress tensor because it is on the same footing as the gravitational self interaction. This makes CC free of the Planck length, and hence it can have any value as determined by the 1997 supernova observation. Thus there is no monumental contradiction of 120 orders.

However the question remains, how should vacuum energy gravitate, and gravitate it must? Of course by enlarging the framework which would ask for a new theory of quantum gravity. Therefore the question would remain open until there emerges a quantum theory of gravity – spacetime!

Hypersymmetry of gravitational and inertial masses in relativistic field theories

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At first, the paper discusses, how the distinction between *gravitational* and *inertial masses* modifies physical equations. Gravitational and inertial masses are – at least near to rest – *quantitatively* equivalent. At the same time, they are *qualitatively* different physical properties. This difference has not been reflected in the traditional physical equations. It makes itself apparent at high velocities relative to the observer, where the two kinds of masses differ also in their quantities. These two kinds of

masses are considered as *isotopic field-charges* (IFC) of the gravitational interaction field. The two, isotopic mass siblings are considered the field-sources of the energy element (T_{00}) in the stress-energy tensor of the gravitational field, and the kinetic (momentum like) tensor elements ($T_{ij}, i, j = 1,2,3$), respectively. Taking into account this issue, it involves changes also in our general view on the physical world.

Putting isotopic masses in equations destroys their Lorentz invariance. This would contradict to our traditional precondition demanded for the physical theories, namely, a long lasting paradigm that equations of the physical interactions must be subject to invariance under the Lorentz-transformation (alone), moreover that it is not only a necessary, but also a sufficient condition. This is not the case: no physical principle stated that Lorentz-invariance is a sufficient condition demanded for the physical equations. There are other invariances that may appear together and combined with Lorentz's.

At second, in order to *restore the* apparently lost *invariance*, the IFC theory disclosed an additional invariance (a symmetry isomorphic with the SU(2) group). There was shown that IFC are subject to a hypersymmetry (HySy, i.e., conservation of a property called the *isotopic field-charge spin*, IFCS) that can transform them into each other (i.e., to rotate the IFC in an abstract IFCS field, where they can occupy two positions). It has been shown that HySy can be characterised by the help of an algebra (called *tau-algebra*). That symmetry guarantees to keep the covariance of our physical field equations. HySy is broken at lower velocities (lower kinetic energies). Therefore, at least near to rest, one can observe the two IFC of the gravitational field equivalent. This indistinguishability is formulated as an equivalence principle. However, equivalence – observed among limited conditions – does not mean identity. We put non-identical masses in physical equations, marking the gravitational and inertial masses by different notations. So, we modified the equations (incl. the gravitational) that led to novel conclusions at high velocities, while it did not result changes near to rest. Our investigations include, how the two isotopic masses behave at high kinetic energies.

At third, this physical description (in contrast to string theories) involves a new approach (among other interactions) to gravity. *Modification of the Gravitational Equation* by inserting the two kinds of mass siblings in the stress-energy tensor, results not only in destroying its Lorentz invariance, but also in a few modifications in its solutions. Without going deep in mathematical details, the paper directs shortly the attention to a few consequences.

In my paper presented at PIRT-2011 (Darvas, 2012), I showed *analytically* a way, how the asymmetry hidden inside the so modified $T'_{\mu\nu}$ can be restored, along with demonstrating the conservation of the IFCS for the isotopic gravitational field charges. Now, I present an *algebraic* way that restores the invariance of the modified energy-momentum tensor under an extended gauge transformation (of the IFCS) by the tau algebra and the group composed of its elements.

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Global geometry of the Vaidya metric

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The classical Vaidya metric (describing, in particular, the nonstationary spherically symmetric black hole with an arbitrary radial flux ejecting or accreting null particles) is popular for very different astrophysical and theoretical applications. In particular, it is used for description of quantum evaporating black holes. The other popular application of Vaidya solution is for the physically reasonable modeling of the relativistic astrophysical objects and cosmological scenarios with radially directed outgoing or ingoing radiation. This metric is also relevant to the problems of the gravitational collapse, internal black hole structure and formation of naked singularities

The fruitful methods for analytic investigations of the Vaidya metric are the using of the double-null coordinates and the linear dependence of the mass function on the null coordinate. We have found the transformation of Vaidya metric to the new diagonal coordinates, which permit the simple analytical solution for all metric functions in the special case of linear growth of the black hole mass. Our crucial ansatz for finding the maximal analytic extension of the Vaidya metric is based on the using of the linear black hole mass function, when the mass accretion or emission rate is constant. By using this ansatz, we can solve our problem analytically. The Vaidya metric with a linear mass function was extensively investigated earlier by

many authors in different aspects. The novelty of our approach with respect to these previous works is in finding of the special diagonal coordinates, which provide the derivation of the exact analytical expressions for all metric functions.

For the detailed investigation of the Vaidya metric with the linear growth of the black hole mass it would be useful transform the initial Vaidya metric to the orthogonal frame with some more “physical” diagonal new coordinates. The use of specific new diagonal coordinates allowed us to reveal the global structure of space-time for Vaidya problem. Exact solutions for radial photon geodesics provided the main tool for this study.

As a result, the global geometry (with the only physical restriction that mass function in the metric is positive) was defined, and the corresponding conformal Carter-Penrose diagram was constructed for different specific cases. These specific cases describe the possible types of the Vaidya metric global geometry, depending on the value of the mass accretion (or ejection) rate. In the case of the Vaidya metric we impose the additional physical constraint: the mass function should be non-negative. Because of this the physical space-time may appear to be geodesically incomplete.

In the described diagonal coordinates it is revealed the narrow region, with the width, proportional to the mass accretion rate, where the described metric is radically differed from the Schwarzschild one. The Vaidya metric in this region cannot be represented as a small perturbation of the Schwarzschild black hole even at the very small value of the accretion rate. It is shown that outside the apparent black hole horizon it is required the set of at least the three coordinate systems to cover the whole domain of variation of the initial nondiagonal coordinates. These three coordinates systems are separated by the singular surfaces, where metric components are zero or infinite. The energy momentum tensor is diverged at these singular surfaces, but the correspondent tidal forces remain finite, which is demonstrated by the analysis of geodesic deviation equations. For these reason the described singular surfaces are purely the coordinate singularities. We called these singular surfaces the “false firewalls” due to the absence of physical singularities on these surfaces.

It is well known that the arbitrary two-dimensional space-time is conformally flat. The Carter-Penrose conformal diagram for the complete two-dimensional flat (Minkowski) space-time is the square with four null infinities as the boundaries. The four-dimensional flat (Minkowskian) space-time written in the spherical coordinates, can be represented, for fixed angles, by the triangle with two null infinities and the timelike (vertical) line of zero radius. When a spherically symmetric space-time is curved, in its different parts the corresponding conformal factors can be different. Beside the “natural” boundaries such as zero radius and infinities, there may exist also the various types of horizons (null, timelike or spacelike ones) manifesting the margins of diagram for the spherically symmetric space-time, consisting of some set of triangles and squares separated by common boundaries.

The main difference between the Schwarzschild space-time and the Vaidya metric is that the nonstationary apparent horizon cannot be an event horizon. Another difference is the construction of infinity. The accretion flow “drags away” the coordinate system causing these qualitative deformations of the geometry.

The derived global geometry seemingly is valid also for a more general behavior of the black hole mass in the Vaidya metric. Note. that some specific properties of the Vaidya metric in the diagonal coordinates were explored earlier by other authors, however without derivation of the corresponding metric functions.

Глобальная геометрия метрики Вайдя

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Классическая метрика Вайдя (описывающая, в частности, нестационарную сферически симметричную черную дыру с произвольным радиальным потоком излучения или аккреции светоподобных безмассовых частиц) популярна для очень разнообразных астрофизических и теоретических приложений. В частности, она используется, для описания квантового испарения черных дыр. Другое популярное приложение решения Вайдя – это физически обоснованное моделирование астрофизических объектов и космологических сценариев с радиально направленными потоками уходящего или приходящего излучения. Эта метрика также используется для описания гравитационного коллапса, внутренней структуры черных дыр и образования голых сингулярностей. Плодотворным методом аналитического исследования метрики Вайдя является использование двойных нулевых координат и линейной зависимости массовой функции от нулевой координаты. Мы нашли новые преобразование исходной метрики Вайдя к новым диагональным координатам, которые допускают простое аналитическое решение для всех метрических функций в специальном случае линейного роста массовой функции (массы черной дыры), когда скорость аккреции или эмиссии постоянна. Используя этот анзац, мы решили поставленную задачу полностью аналитически. Метрика Вайдя с линейной функцией массы интенсивно исследовалась ранее многими авторами и в различных аспектах. Новизна нашего подхода по сравнению с прежними исследовании заключается в нахождении специальной системы координат, позволившей получить аналитическое решение для всех метрических функций. Для детального исследования метрики Вайдя с линейным ростом массы черной дыры удобно сделать преобразование координат исходной метрики Вайдя, в которой одна из координат светоподобная (нулевая), к более “физической” ортогональной системе координат. Использование специфических диагональных координат позволило нам исследовать глобальную.геомертию метрики Вайдя. Основным инструментом в этом исследовании были точные радиальные светоподобные геодезические. В результате, была найдена глобальная геометрия метрики Вайдя и построены соответствующие конформные диаграммы Картера-Пенроуза для различных специфических

случаев. Эти специфические случаеи описывают возможные глобальные геометрии в зависимости от величины скорости аккреции (или эжекции). В случае метрики Вайдя мы использовали дополнительное физическое ограничение, а именно, считали, что массовая функция не отрицательна. По этой причине построенное результирующе пространство-время может быть геодезически неполным. В используемой диагональной системе координат обнаружена узкая область с шириной, пропорциональной скорости аккреции (эжекции), в которой метрика радикально отличается от метрики Шварцшильда. Метрика Вайдя в этой области не может быть представлена как малое возмущение решения Шварцшильда даже при очень малых значениях скорости аккреции. Показано, что вне горизонта видимости требуется по крайней мере три системы координат, чтобы полностью покрыть область возможных значений исходных недиагональных координат. Эти три системы координат разделены сингулярными поверхностями, где метрические компоненты обращаются в ноль или в бесконечность. На этих сингулярных поверхностях расходится тензор энергии-импульса, однако, с помощью анализа уравнений девиации геодезических показано, что соответствующие приливные силы остаются конечными. По этой причине описываемые сингулярные поверхности являются чисто координатными особенностями. Мы назвали эти сингуляпные поверхности “фальшивыми огненными стенками”. Конформная диаграмма Картера-Пенроуза для четырехмерного плоского пространства-времени Минковского в сферической системе координат может быть представлено (при фиксированных углах) в виде треугольника с двумя нулевыми бесконечностями и времениподобной (вертикальной) линией нулевого радиуса. В случае кривого сферически симметричного пространства-времени в его различных областях соответствующие конформные факторы могут быть различными. Помимо “естественных” границ, таких, как нулевой радиус и бесконечности, могут существовать также различные типы горизонтов. В результате, построенные диаграммы состоят из ряда треугольников и квадратов, разделенных общими границами. Основное различие между пространством временем Шварцшильда и Вайдя связано с появлением в последнем случае нестационарного горизонта видимости, не совпадающего с горизонтом событий. Другое различие проявляется в структуре координатных бесконечностей. Аккреционный поток “растягивает” системы координат, приводя к качественной деформации результирующей геометрии. Полученная структура глобальной геометрии, по-видимому, справедлива и для более общего поведения массовой функции в метрике Вайдя. Отметим, что некоторые специфические особенности метрики Вайдя исследовались ранее другими авторами, однако, без вывода соответствующих метрических функций.

Super-Poynting vector and commoving observers in the Einstein-Rosen spacetime

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The classification of gravitational fields through the four independent algebraic invariants of the Weyl tensor allows us to set conditions to find the observer for which the field is purely quasi-electric or purely quasi-magnetic. Furthermore, through the vanishing of the super-Poynting vector it is possible to find the observers at rest with respect to the gravitational field. In this work we found the comoving observers with the Einstein-Rosen gravitational waves and obtained their corresponding 3-velocity of propagation. We analyzed specific cases such as freely propagating monochromatic waves and the Weber-Wheeler-Bonnor pulse. Finally, we also considered the superposition of the aforementioned waves with the exterior field of a static cylinder filled with matter.

Induced actions for higher-spin fields

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The actions for free relativistic fields posses conserved currents of all spins. While lower-spin ($s \leq 2$) currents have important phenomenological and theoretical uses - spin-1 currents form the base for electromagnetic, weak and strong interactions as described by The Standard Model of elementary particle physics, spin-2 current forms the base for gravitational interactions as described by The General Relativity, and spin $1/2$ and $3/2$ are essential for supersymmetry and supergravity - higher-spin ($s > 2$) currents have no such important implications and uses. As higher-spin free fields can be easily constructed, it would be natural to expect that one can construct interactions with the „matter sector“ by coupling to the higher-spin currents. However, it is known that there are serious constraints and no-go theorems, especially strong when higher-spin fields are massless and (background) spacetime is flat. As a consequence, construction of consistent interacting theories with higher-spin fields appeared to be complicated task. On the other hand, string theory has excitations of all spins even when defined on flat spacetime, and moreover in the tensionless limit higher-spin excitations become massless.

We calculate, on the 1-loop level, 2-point correlators of conserved currents of spins $1 \leq s \leq 10$ in free theories of massive scalar and Dirac fields in flat $3 \leq D \leq 6$ spacetime dimensions. Parts of the correlators have universal form and can be written

in closed form as functions of *s* and *D*. Infrared and ultraviolet limits are analysed in detail.

If one couples the conserved current to higher-spin background field, the 2-point correlator is giving us linearised induced equations of motion and quadratic part of the induced action for higher-spin field. Using lower-spin cases as guidelines, we analyse infrared and ultraviolet limits, which should give us information on classical action and UV behaviour, respectively, of higher-spin theories, if such exist. We express our results in terms of generalised linearised Riemann tensor, and compare our results with the literature.

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Axion-graviton telescope

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Some physical mechanisms of axion and graviton transformation to photons in external electromagnetic field are stated. Conditions and features of this process are analyzed. Community and distinctions in polarization and amplitude-frequency dependence of final photons are specified.

In addition features of conversion of the axion having non zero mass are considered. It is shown that in this case it is necessary use more complicate configuration of magnetic field.

Capacities of various sources of axion and gravitons are estimated. In particular two main mechanisms – bremsstrahlung and conversion of photons to axion or graviton in the local electromagnetic field are considered. Comparison from these parameters for powerful x-ray stars and the Sun is carried out. It is shown that first mechanism, due to the fact that its efficiency on power is proportional to a square of density of substance, will be on 25-30 orders of magnitude more in neutron stars, than in the Sun. The photons conversion mechanism on neutron stars in magnetic fields of $H \sim 10^{12}$-10^{14} will be also approximately more effective on 25-30 orders than in the Sun. It means that despite the short distance to the Earth, the Sun can be not the brightest source of axion and gravitons.

Some variants of telescope design are considered and the comparative analysis of their efficiency is carried out. In particular it is shown that the telescope with

dipole magnetic field along a pipe axis (solenoid) doesn't lead to registration axion and gravitons in principle. It is connected with that it is strictly necessary for axion and gravitons conversion to photons that their wave vector would be perpendicular to magnetic field. For achievement of this purpose it is necessary to make a telescope with axial configuration of magnetic field. Such distribution will be in a pipe with a current-carrying wire on a pipe axis.

Possibilities of use of static electric field instead of magnetic are discussed in addition. Possible parameters of such designs are estimated.

Аксионо-гравитонный телескоп

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В докладе излагаются физические механизмы трансформации аксионов и гравитонов в фотоны во внешнем электромагнитном поле. Анализируются условия и особенности этого процесса. Указано на общность и различия в поляризации и амплитудно-частотной зависимости конечных фотонов.

Дополнительно рассматриваются особенности конверсии аксионов, имеющих не нулевую массу покоя. Показано, что в этом случае необходимо более сложную конфигурацию магнитного поля.

Оцениваются мощности различных источников аксионов и гравитонов. В частности рассматриваются два основных механизма – тормозной и конверсия фотонов в аксионы и гравитоны в локальном электромагнитном поле. Проводится сравнение мощности рентгеновских звезд и Солнца. Показано, что тормозной механизм ввиду того, что его эффективность по мощности пропорциональна квадрату плотности вещества будет на 25-30 порядков больше на нейтронных звездах, чем на Солнце. Механизм конверсии фотонов на нейтронных звездах в магнитных полях $H \sim 10^{12}$-10^{14} гс также будет примерно на 25-30 порядков более эффективным, чем на Солнце. Это означает, что несмотря на близость к Земле, Солнце может быть далеко не самым ярким источников аксионов и гравитонов.

Рассматриваются некоторые варианты дизайна наземных телескопов и проводится сравнительный анализ их эффективности. В частности показано, что телескоп с дипольным магнитным полем вдоль оси трубы (соленоид) не приводит к регистрации аксионов и гравитонов в принципе. Это связано с тем, что для конверсии аксионов и гравитонов в фотоны необходимо, чтобы их волновой вектор был перпендикулярен магнитному полю. Для достижения этой цели необходимо делать трубу телескопа с аксиальным распределением магнитного поля. Такое распределение будет в трубе с токонесущим проводом по оси трубы.

Дополнительно обсуждаются возможности использования статического электрического поля вместо магнитного. Оценены возможные параметры таких конструкций.

Local Hubble Expansion: Current State of the Problem

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The question if the planetary systems experience the universal cosmological expansion was posed by McVittie [1] as early as 1933, when the concept of expanding Universe became the dominant paradigm in cosmology. Although, a quite large number of theoretical studies were conducted in the subsequent few decades, they did not give us a definitive answer to the above-mentioned question, because they employed the various simplified models [2].

However, in the last decade we can see a revival of interest in this problem. This was caused, first of all, by the fact that, at the empirical level, the local Hubble expansion can easily resolve a number of the long-standing problems in the dynamics of Solar system and planetology. They are, for example, the so-called lunar tidal catastrophe (*i.e.*, the anomalous recession rate of the Moon from the Earth, exceeding the value expected from the tidal effects) [3-4], the faint young Sun paradox (insufficient luminosity of the Sun 2– billion years ago to support a geological and biological evolution of the Earth) [5-6], the problem of “fast satellites” of the planets, *etc*. The corresponding issues were discussed at the International Conference “Cosmology on Small Scales: Local Hubble Expansion and Selected Controversies in Cosmology”, held in Prague on September 21–24, 2016 [7] (for more details, see: http://css2016.math.cas.cz).

Yet another approach to the above-mentioned problem, which is discussed in the last couple years, are the specifically-designed high-precision experiments to reveal Hubble expansion within the Solar system. However, such experiments suffer from a lot of interfering effects and, from our point of view, a more promising approach is seeking for the local Hubble expansion in the long-term evolution of the solar-system bodies.

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Локальное хаббловское расширение: Современный статус проблемы

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Вопрос о том, испытывают ли планетные системы универсальное космологическое расширение, был поставлен Мак Витти [1] еще в 1933г., когда концепция расширяющейся Вселенной стала доминирующей парадигмой в космологии. Хотя в последующие десятилетия было проведено достаточно большое количество теоретических исследований, они так и не дали однозначного ответа на сформулированный выше вопрос, поскольку использовали различные упрощенные модели [2].

Тем не менее, в последнее десятилетие мы можем видеть возрождение интереса к данной проблеме. Это связано в первую очередь с тем фактом, что на эмпирическом уровне эффект локального хаббловского расширения позволяет легко решить ряд давно стоявших проблем динамики Солнечной системы и планетологии. Это, например, так называемая "лунная приливная катастрофа" (аномальная скорость удаления Луны от Земли, превышающая значение, ожидаемое от приливных эффектов) [3-4], парадокс "тусклого молодого Солнца" (недостаточная светимость Солнца 2-4 млрд. лет назад для обеспечения геологической и биологической эволюции Земли) [5-6], проблема "быстрых спутников" планет и др. Все эти вопросы обсуждались на Международной конференции "Космология на малых масштабах: локальное хаббловское расширение и отдельные противоречия в космологии" ("Cosmology on Small Scales: Local Hubble Expansion and Selected Controversies in Cosmology"), которая состоялась в Праге 21-24 сентября 2016г. [7] (более подробная информация имеется по адресу: http://css2016.math.cas.cz).

Еще один подход к вышеупомянутой проблеме, который стал обсуждаться в последние пару лет – это специально-поставленные высокоточные эксперименты для выявления хаббловского расширения в пределах Солнечной системы. Однако, такие эксперименты подвержены огромному количеству мешающих эффектов и поэтому, с нашей точки зрения, более перспективным подходом остается поиск локального хаббловского расширения в долгосрочной эволюции тел солнечной системы.

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Gravitational waves from primordial black holes collisions in binary systems

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The first direct detection of gravitational waves was done September 14, 2015 by two laser interferometers LIGO. The form of the GW150914 signal corresponds to the general relativity prediction for the merge of two black holes with 36 and 29 solar masses, and the statistical significance of the registration is 5.1σ. This result demonstrates the existence black holes in the binary systems. Such black holes can born at the massive supernova explosions as a result of the stellar evolution. In particular, the low-metallicity environment boosts the massive double black holes formation. It is possible, however, that the black holes were born in the collapse of massive pre-galactic stars, or they were formed by merge of smaller black holes in the dense star clusters.

The merge of primordial black holes in a pairs provides the alternative explanation of GW150914 (Nakamura et al. 1997; Ioka et al. 1998; Sasaki et al. 2016). The possibility of primordial black holes formation was predicted by Ya.B. Zel'dovich and I.D. Novikov in 1967, and there are many particular scenarios of their formation. For concreteness we consider in this work the formation of primordial black holes from adiabatic cosmological density perturbations (curvature perturbation).

The primordial black holes pair can form occasionally if two primordial black holes born sufficiently close to each other (Nakamura et al. 1997). The motion of the binary primordial black holes is influenced by gravitational field of the neighboring third primordial black hole, therefore the primordial black holes do not move exactly towards each other but experience tangential displacement under the influence of the tidal gravitational forces from the third primordial black hole (Nakamura et al. 1997; Ioka et al. 1998; Sasaki et al. 2016).

In this study we consider the additional source of tidal forces - the tidal forces from the usual inflationary density perturbations in dark matter. This effect was not considered previously in the calculations of the primordial black holes pair's evolution. We consider the evolution of binary primordial black holes at the cosmological stage of radiation dominance during the first orbital period. We solve the system of evolution equations numerically until the binary expands up to the maximum distance (this distance is the major semi-axis of the orbit) and then approaches twice in radius. The separation of the pair at this moment gives the size of the minor axis. Neighboring third primordial black hole is not the only sources of disturbing. Tidal forces can be produced also by the dark matter density perturbations, and the main contribution comes from the characteristic scale, where dark matter mass is equal to the primordial black hole mass. Then the probability distribution over orbital parameters and the pairs merge rate due to gravitational waves emission were calculated.

As a result, the additional tidal forces alter the distribution of primordial black holes pairs over their orbital parameters, and finally suppress the rate of the gravitational bursts by the factor ~ 2-4 in comparison with previous calculations. This rate matches the LIGO data if the primordial black holes constitute the fraction of dark matter ~ 1.1×10^{-3} - 6.5×10^{-3}.

The close primordial black holes pairs form at the cosmological stage of the radiation dominance, but they can also form later at the stage of matter domination. A halo of dark matter is accumulated around the primordial black holes by the secondary accretion mechanism. The primordial black holes in the halo experience the dynamic friction, lose angular momentum and move toward the center, there they form the gravitationally bounded binary, even if they were not associated initially. This effect can additionally increase the merge rate of the primordial black holes binaries.

Гравитационные волны от столкновений первичных черных дыр в двойных системах

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Первая прямая регистрация гравитационных волн осуществлена 14 сентября 2015 г. двумя лазерными интерферометрами LIGO. Форма сигнала GW 150914 соответствует предсказаниям общей теории относительности для слияния двух черных дыр с массами 36 и 29 масс Солнца, а статистическая значимость регистрации составляет 5.1σ. Этот результат демонстрирует существование черных дыр в двойных системах. Такие черные дыры могли рождаться при взрывах массивных сверхновых в результате эволюции звезд. В частности, массивные двойные черные дыры могли возникать в областях с

низкой металличностью газа. Возможно, однако, что черные дыры рождались в результате взрывов массивных догалактических звезд или образовывались путем слияния черных дыр с меньшими массами в плотных звездных скоплениях.

Слияние первичных черных дыр в парах дает альтернативное объяснение гравитационному всплеску GW 150914 (Nakamura et al., 1997; Ioka et al., 1998; Sasaki et al., 2016). Возможность образования первичных черных дыр была предсказана Я.Б. Зельдовичем и И.Д. Новиковым в 1967 году, и существует множество сценариев их формирования. Для определенности, в данной работе мы рассматриваем образование первичных черных дыр из адиабатических космологических возмущений плотности (возмущений кривизны).

Пара первичных черных дыр может образоваться стохастически, если две первичные черные дыры рождаются достаточно близко друг к другу (Nakamura et al., 1997). На движение двойных первичных черных дыр влияет гравитационное поле соседней третьей первичной черной дыры, поэтому первичные черные дыры не притягиваются строго по направлению друг к другу, а испытывают поперечное смещение под действием приливных гравитационных сил со стороны третьей первичной черной дыры (Nakamura et al. 1997, Ioka et al., 1998, Sasaki и др., 2016). В данной работе мы рассматриваем дополнительный источник приливных сил - приливные силы со стороны обычных инфляционных возмущений плотности в темной материи. Этот эффект ранее не учитывался при расчетах эволюции двойных первичных черных дыр. Мы рассматриваем эволюцию двойных первичных черных дыр на космологической стадии радиационного доминирования в течение первого орбитального периода. Мы решаем численно систему уравнений эволюции орбиты до тех пор, пока пара не расширится до максимального расстояния (это расстояние равно главной оси орбиты), а затем сблизится радиусу на вдвое меньшее расстояние. Расстояние между компонентами пары в этот момент дает размер малой оси. Соседняя третья первичная черная дыра является не единственным источником возмущений. Приливные силы могут создаваться также возмущениями в темной материи, и основной вклад вносит характерный масштаб, на котором масса темной материи равна массе первичной черной дыры. Далее вычисляется вероятностное распределение по орбитальным параметрам и темп слияния пар из-за излучения ими гравитационных волн.

В результате, дополнительные приливные силы изменяют распределение пар первичных черных дыр по их орбитальным параметрам и уменьшают темп гравитационных всплесков в ~ 2-4 раза по сравнению с результатами предшествующих расчетов. Этот темп соответствует данным LIGO, если первичные черные дыры составляют долю темной материи ~ 1.1×10^{-3} - 6.5×10^{-3}.

Тесные пары первичных черных дыр формируются на космологической стадии радиационного доминирования, но они могут также сформироваться позднее на стадии доминирования вещества. В результате вторичной аккреции вокруг первичных черных дыр накапливается гало темной материи. Первичные черные дыры в этих гало испытывают динамическое трение, теряют угловой момент и движутся к центру, где они образуют гравитационно связанную

двойную систему даже в том случае, если они не были связаны изначально. Этот эффект может дополнительно увеличить темп слияния первичных черных дыр в двойных системах.

Field Interpretation of General Relativity

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According to R. Feynman, gravity has both a field and geometric interpretation [1]. A. Eddington wrote: "… it is likely that some of the phenomena will be determined by comparatively simple equations in which the components of curvature of the world do not appear; such equations will be the same for a curved region as for a flat one…" [2]. Below the field interpretation of General Relativity will be exemplified by three well-known cases: a) a static centrally symmetric gravitational field, b) radiation of gravitational waves, c) a homogeneous isotropic cosmological model, without resorting to Einstein-Hilbert's equations.

Static metrics (Schwarzschild's, Reissner-Nordström's, de Sitter's) were demonstrated to be derivable

$$\Delta\varphi = 4\pi G\rho_{eff}, \tag{1}$$

where ρ_{eff} is the effective mass density, using the formula relating the temporal component of the metric g_{00} to the gravitational potential φ:

$$g_{00} = 1 + \frac{2\varphi}{c^2} \tag{2}$$

For the Newtonian gravitational potential

$$\varphi = -\frac{GM}{r} \tag{3}$$

where M is the mass of a gravitational field source, formula (2) gives an exact expression for Schwarzschild's metric. Thus (2) is valid in the general case, but not only in the nonrelativistic one, as often mentioned.

Einstein's formula for the intensity of gravitational radiation

$$I = \frac{2G}{5c^5}\dddot{D}_{\alpha\beta}\,\dddot{D}^{\alpha\beta} \tag{4}$$

is derivable from that of electric quadrupole radiation by substituting the quadrupole moment of a charge by that of a mass $D_{\alpha\beta}$, introducing the gravitational constant G and replacing the spin $s = 1$ of a vector field for the photon by the spin $s = 2$ for a symmetric tensor one for the graviton [1]. It is no way follows that a gravitational tensor field is related to a curved space-time, which involves introducing a gravitational field pseudotensor. The latter is not invariant under coordinate transformations [3].

Friedmann's equations derived from General Relativity for a homogeneous isotropic cosmological model are obtainable in the framework of Newtonian theory [4].

Degeometrization of General Relativity (without changing its results (e.g., gravitational red shift, light deflection, perihelion shift etc.) allows the gravitational interaction to be unified with the others described in the framework of the Standard model of particle physics. Maybe it is an effective Riemannian space that is used for involved calculations.

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The Resonance γ+γ→*p*γ Conversion in the *f*-block of the Periodic Table

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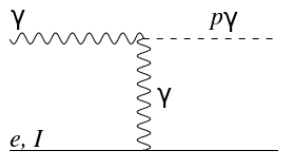
According to the modern conception of the Universe's evolution at an early stage of its existence there was a vacuum phase transition lead to the vacuum torsion described by the Higgs field. The Universe has become gyrotropic that violated the *T*-symmetry.

The order parameter for this gyrotropic phase transition is the vacuum twist angle θ and the soft mode is the Goldstone one and it determines the oscillations around the θ_0. The key feature of the Goldstone mode is its scalarity so the sought Goldstone quantum must be a scalar particle.

We assume that the best candidate for the goldstone is the paraphoton, quasiparticle similar to the Cooper pair in a superconductor. In the Bardeen-Cooper-Schrieffer theory two opposite spins electrons in the periodic crystal lattice potential can combine a spinless pair which is the zero spin boson and therefore it moves through the bulk without energy losses. It means that there is no way to observe this quasiparticle in the superconductive medium. So we think that the similar way two opposite spins photons can pairing to the scalar paraphoton that ceases to interact with the environment and therefore becomes the "dark" particle:



The two photons - to - paraphoton conversion Lagrangian is $L \sim \psi_s E^2$, so one have to imply the superstrong electric field to observe the process. Besides, there is another way: to slow the light. Due to the conservation of the energy flux density $< S >= \varepsilon_0 E^2 = wv$, so for the slow light $E^2 = E_0^2 \frac{c}{v}$ and the Lagrangian is proportional to the deceleration: $L \sim \frac{c}{v}$. It means that the light deceleration to 1 m/s increases the conversion probability by 8 orders of magnitude.

The diagram show that the medium's presence is critical to the process (to conserve the quasipulse) but the selection rules allow the conversion only for the absolutely transparent media ($n = 1$). As we show in papers [1-5] this can be realized in the dielectric media at the unitary polaritons' frequencies (for which $n = 1$, as in the vacuum). If these ones are close to the one of medium oscillators' frequencies then the density of states is maximal, $v \to 0$ and conversion is resonant.

Thus, the best media for photon-paraphotonic conversion must have the largest possible number of electronic oscillators. Such chemical elements are located at the bottom of the periodic table, lanthanides and actinides (*f*-elements). In this paper we present the results of our studies of the photon-paraphotonic conversion in the sodium uranyl acetate.

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Резонансная $\gamma + \gamma \rightarrow p\gamma$ конверсия в соединениях f-элементов Периодической системы

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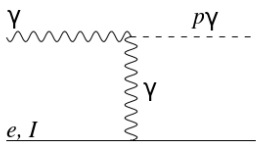
Согласно современным представлениям об эволюции Вселенной на раннем этапе ее существования произошел фазовый переход, приведший к формированию микроструктуры вакуума и возникновению поля Хиггса, характеризующего закрученность пространства-времени. Вселенная стала гиротропной, что привело к нарушению *T*-симметрии.

Параметром порядка для такого гиротропного фазового перехода является угол закрученности вакуума θ, а мягкая мода – мода Голдстоуна – соответствует колебаниям вокруг положения θ_0 и является скалярной.

Мы предполагаем, что наилучшими кандидатами на роль голдстоуновских квантов являются парафотоны – квазичастицы, аналогичные электронным куперовским парам в сверхпроводнике. В теории Бардина-Купера-Шриффера два электрона с противоположными спинами в периодическом поле кристаллической решетки могут объединиться в куперовскую пару, являющуюся скалярным бозоном, что позволяет двигаться в веществе без потерь энергии (то есть, “не взаимодействуя” с ним). Мы считаем, что аналогичным образом два фотона с противоположными спинами в материальной среде могут сформировать скалярный парафотон, не взаимодействующий с окружением и, тем самым, являющийся "темной" частицей:



Лагранжиан рассматриваемого двухфотонного процесса должен содержать слагаемое, пропорциональное квадрату напряженности электрического поля $L \sim \psi_s \cdot E^2$. Следовательно, для наблюдения парафотонов в лабораторных условиях необходимы сверхсильные электрические поля. Однако эффекта можно добиться и иначе – замедляя свет. В силу непрерывности вектора Пойнтинга $\langle S \rangle = \varepsilon_0 \cdot E^2 = w \cdot \mathrm{v}$ имеем: $E^2 = E_0^2 \cdot (c/\mathrm{v})$, поэтому лагранжиан пропорционален (c/v) и замедление групповой скорости света v до 1 м/с повышает вероятность конверсии на 8 порядков.

Как видно из диаграммы, материальная среда является существенно необходимой, однако правила отбора разрешают процесс конверсии только при

$n = 1$. Как было показано в работах [1-5], это возможно в диэлектрических средах на частотах унитарных поляритонов (для которых $n = 1$, как в вакууме). Если при этом частота унитарного поляритона оказывается близкой к собственной частоте лоренцевого осциллятора среды, плотность связанных состояний близка к максимальной, $v \to 0$ и конверсия становится резонансной.

Таким образом, для регистрации процессов фотонных-парафотонных превращений наиболее перспективны среды, обладающие максимально возможным числом электронных осцилляторов. Соответствующие элементы располагаются в конце таблицы Менделеева и относятся к лантаноидам и актиноидам (*f*-элементам). В данной работе мы представляем результаты наших исследований процесса фотон-парафотонной конверсии в уранилацетате натрия.

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To the issue of reconciling quantum mechanics and General relativity

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Starting from the 70s it became evident that in the quantum domain numerical value of G is not compatible with the principles of quantum mechanics. A number of studies have shown that in the quantum domain acceptable is constant K, where in $K \approx 10^{40}G$. This marked the problem of generalization of the relativistic equations for the quantum level: this generalization should join the numerical values of the constants in quantum and classical fields. In the development of these results as an approximation to the micro level of the field equations of Einstein, a model based on the following assumptions is proposed:

The gravitational field in the region of localization of elementary particles with mass m_0 is characterized by the values of the gravitational constant K and constant Λ, which lead to the stationary states of a particle in its own gravitational field, and

stationary states of the particles themselves are the source of the gravitational field with the Newtonian gravitational constant G.

In the simplest (in terms of initial mathematical evaluations) approximation, the problem for stationary states in its gravitational field (with the constants K and Λ) was solved . From the solution of this problem should be:

a) If the numerical values of $K \approx 5.1 * 10^{31}\, Nm^2kg^{-2}$ and $\Lambda = 4.4 * 10^{29}m^{-2}$, there is a spectrum of stationary states of the electron in its own gravitational field (0.511 MeV ... 0.681 MeV). The main state is the observed electron rest energy 0.511 MeV. *This numerical value of Λ has important physical meaning: an introduction to the Lagrangian density permanent member, not dependent on the state of the field. This implies the existence of unremovable space-time curvature, not affiliated with any matter, nor with the gravitational field.*

b) These steady states are the sources of the gravitational field with constant G.

c) Transitions between the stationary states of the electron in its own gravitational field leads to gravitational radiation, which is characterized by a constant K, that gravitational radiation is the emission of the same level as electromagnetic .In this regard, it makes no sense to say that the gravitational effects in the quantum region are characterized by the constant G. This constant applies only to the macroscopic field and it can not be transferred to the quantum level (which, by the way, we remind, show negative results for the detection of gravitational waves with the constant G, and they can not be). It is considered that according to General Relativity (GR), gravitational radiation can generate only system with variable quadrupole or higher multipole moments. Under this assumption, the corresponding power of gravitational radiation is determined by the relationship:

$$L = \frac{1}{5}\frac{G}{c^5}\langle\frac{d^3Q_{ij}}{dt^3}\frac{d^3Q^{ij}}{dt^3}\rangle,$$

where Q_{ij} is a quadrupole moment tensor of the mass distribution of the radiating system, and the constant in this relationship defines the order of magnitude of the radiation power. Wrongfulness of this formula, as follows from the above, is not to use the quadrupole approximation, but in the scheme calculation. The presence of stationary states in the own gravitational field allows the correct calculation of gravitational radiation in the strict quantum approach based on the spectrum of transitions to stationary states already with constant K. It is permissible to use not only quadrupole, but also dipole quantum approach, which is quite obvious. Gravitational waves with the constant G do not exist. *That is evidenced by the negative results of the detection of gravitational waves, based on the assumption of a completely illegitimate assumption of gravitational wave generation by any mass distribution with variable multipole (starting with quadrupole) moments.*

К вопросу о совмещении квантовой механики и общей теории относительности

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Начиная с 70-х годов, стало очевидным, что в квантовой области численное значение G не совместимо с принципами квантовой механики. В ряде работ было показано, что в квантовой области приемлема константа связи K, причем $K \approx 10^{40}G$. Это и обозначило суть проблемы обобщения релятивистских уравнений на квантовом уровне: такое обобщение должно стыковать численные значения констант в квантовой и классической областях. В развитие этих результатов, в качестве приближения на микроуровне полевых уравнений Эйнштейна, предлагается модель, основанная на следующем предположении:

Гравитационное поле в области локализации элементарной частицы с массой m_0 характеризуется такими значениями гравитационной постоянной K и постоянной Λ, которые приводят к стационарным состояниям частицы в собственном гравитационном поле, а сами стационарные состояния частиц являются источником гравитационного поля с ньютоновской гравитационной постоянной G.

В простейшем (с точки зрения исходных математических оценок) приближении задача на стационарные состояния в собственном гравитационном поле (с константами K и Λ) решена. Из решения этой задачи следует:

a) При численных значениях $K \approx 5.1 * 10^{31}\ Nm^2kg^{-2}$ и $\Lambda = 4.4 * 10^{29}m^{-2}$ существует спектр стационарных состояний электрона в собственном гравитационном поле (0.511 MeV …0.681 MeV). Основным состоянием является наблюдаемая энергия покоя электрона 0.511 MeV. . *Такое численное значение Λ означает глубокий физический смысл: введение в плотность функции Лагранжа постоянного члена, не зависящего от состояния поля. Это означает наличие у пространства-времени неустранимой кривизны, не связанной ни с материей, ни с гравитационным полем.*

b) Эти стационарные состояния являются источниками гравитационного поля с постоянной G.

c) Переходы по стационарным состояниям электрона в собственном гравитационном поле приводят к гравитационному излучению, которое характеризуется именно постоянной K, т.е. гравитационное излучение является излучением одного уровня с электромагнитным. В связи с этим не имеет смысла говорить о том, что гравитационные эффекты в квантовой области характеризуется постоянной G, эта постоянная относится только к макроскопической области и это нельзя переносить на квантовый уровень.

Принято считать, что согласно Общей Теории Относительности (GR), гравитационное излучение могут генерировать только системы с переменным квадрупольным или более высокими мультипольными моментами. В таком предположении мощность соответствующего гравитационного излучения определяется зависимостью:

$$L = \frac{1}{5}\frac{G}{c^5}\langle\frac{d^3Q_{ij}}{dt^3}\frac{d^3Q^{ij}}{dt^3}\rangle$$

где Q_{ij} – тензор квадрупольного момента распределения масс излучающей системы, а константа, входящая в эту зависимость даёт порядок величины мощности излучения. Неправомерность использования этой формулы, как следует из вышеизложенного, заключается не в использовании квадрупольного приближения, а в схеме расчёта. Наличие стационарных состояний в собственном гравитационном поле даёт возможность правильного вычисления мощности гравитационного излучения в строгом квантовом приближении исходя из спектра переходов по стационарным состояниям, причём уже с константой K. Гравитационных волн с постоянной G нет и не может быть. Именно об этом свидетельствуют отрицательные результаты по регистрации гравитационных волн, основанные на совершенно неправомерном предположении о генерации гравитационных волн *любым* распределением масс с переменными мультипольными (начиная с квадрупольного) моментами.

The exact solutions in cosmological models with Gauss-Bonnet scalar

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The models of cosmological inflation in the Einstein gravity model with additional Gauss-Bonnet term which is non-minimally coupled to a scalar field are considered in this work. Also, it is proved that in such models inflationary solutions of exponential and power-law types are allowable and few examples of them were found.

For the very early Universe approaching to the Planck scale, it is possible to consider Einstein gravity with some corrections as the effective theory of the ultimate quantum gravity. For instance, the higher derivative terms of gravity with nontrivial gravitational self-interactions naturally appear in the low energy limits of string theories. The effective supergravity action from superstrings induces correction terms of higher order in the curvature, which may play a significant role in the early Universe. The simplest such correction is the Gauss-Bonnet term in the low-energy effective action of the heterotic strings.

The method of the exact cosmological solutions construction for a single scalar field with non-minimal coupling with Gauss-Bonnet scalar in Friedmann-Robertson-

Walker Universe on the basis of connection with standard cosmological models is also proposed. The system of equations with the special ansatz in the form which allows generating the exact solutions for wide class of cosmological models by setting the scale factor was presented. On the basis of the exact solutions which were obtained, the cosmological models that include both stages of the accelerated expansion of the universe are considered.

Точные решения в космологических моделях со скаляром Гаусса-Бонне

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В настоящей работе рассматриваются модели космологической инфляции с гравитацией Эйнштейна и дополнительным членом Гаусса-Бонне, неминимально связанным со скалярным полем. Кроме того, показано, что в таких моделях допустимы инфляционные решения экспоненциального и степенного типов, и были найдены несколько примеров таких моделей.

Для очень ранней Вселенной, приближающейся к планковским масштабам, гравитацию Эйнштейна с некоторыми добавками можно рассматривать как эффективную теорию квантовой гравитации в предельном случае. Например, слагаемые, содержащие высшие производные с нетривиальным гравитационным самодействием естественно появляются в низкоэнергетических пределах струнных теорий. Эффективное супергравитационное действие суперструн вызывает поправочные члены более высокого порядка по кривизне, которые могут играть значительную роль в ранней Вселенной. Простейшим случаем такой поправки является член Гаусса-Бонне в низкоэнергетическом эффективном действии гетеротических струн.

Также предлагается метод построения точных космологических решений с одним скалярным полем неминимально взаимодействующим со скаляром Гаусса-Бонне во Вселенной Фридмана-Робертсона-Уокера на основе связи со стандартными космологическими моделями. Представлена система уравнений со специальным анзацем в форме, которая позволяет генерировать точные решения для широкого класса космологических моделей, путем задания масштабного фактора. На основе полученных точных решений рассматриваются космологические модели, включающие обе стадии ускоренного расширения Вселенной.

Prolonged almost AP-structures in unified theory of gravitational and electromagnetic interactions

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A model of gravitational and electromagnetic interactions that is a variant of the Kaluza-Klein theory and is based on the usage of the prolonged almost contact metric structure defined on the distribution of a three dimensional metric manifold, is proposed. In that model, the space of velocities of the moving particles form the four dimensional distribution of the prolonged almost contact metric structure, defined on a five dimensional manifold. The prolonged almost contact metric structure is defined as a prolonged connection [1] of a contact metric manifold. The prolonged connection is given by the interior connection of the contact metric manifold equipped with a field N of admissible endomorphisms.

Namely, an N-prolonged connection [1] is called a connection in the vector bundle (D, π, M) defined by the decomposition $TD = \widetilde{HD} \oplus VD$, where $\widetilde{HD} = HD \oplus Span(\vec{u})$, $\vec{u}_{\vec{x}} = \vec{\varepsilon} - (N\vec{x})^v$, $\vec{\varepsilon} = \partial_n$, $\vec{x} \in D$, $(N\vec{x})^v$ is the vertical leaf.

It is shown that the equations of admissible geodesics, under a proper choice of the prolonged connection, coincide with the equations of motion of a charged particle in general relativity. Conditions for a manifold with a prolonged almost contact metric structure to be an Einstein manifold, are found. The used construction is founded on the theory of manifolds with almost *AP*-structures currently been developing by the author. An almost *AP*-manifold is a generalization of a SQS-manifold (quasi-Sasakian manifold) that satisfy additional conditions. Quasi-Sasakian manifolds have been carefully studied in the worked by V.F. Kirichenko and his students. Interesting examples of SQS-structures provide structures naturally appearing on the zero curvature distributions of Sasakian manifolds. The idea of the prolongation of an almost contact metric structure is founded on a construction by Sasaki. Due to the natural splitting of the tangent bundle TTM of the manifold TM into the direct sum of the vertical and horizontal distributions, on the manifold TM appears a structure of a Riemannian manifold with a Sasakian metric. The distribution D of an almost contact metric structure $\left(M, \vec{\xi}, \eta, \varphi, g, D\right)$ is an odd analogue of the tangent bundle, and similarly to the tangent bundle it can be supplied with a structure of a Riemannian *AP*-manifold. More precisely, on the distribution D appears the structure $(D, J, \vec{u}, \lambda = \eta \circ \pi_*, \tilde{g}, \widetilde{D})$, defined by the equalities

$$\tilde{g}(\vec{x}^h, \vec{y}^h) = \tilde{g}(\vec{x}^v, \vec{y}^v) = g(\vec{x}, \vec{y}),$$
$$\tilde{g}(\vec{x}^h, \vec{y}^v) = \tilde{g}(\vec{x}^v, \vec{y}^h) = \tilde{g}(\vec{x}^h, \vec{u}) = \tilde{g}(\vec{x}^v, \vec{u}) = 0,$$
$$J\vec{x}^h = -(\varphi\vec{x})^h, \;\; J\vec{x}^v = (\varphi\vec{x})^v, \;\; J(\vec{u}) = \vec{0}, \;\; \vec{x}, \vec{y} \in \Gamma(D), \;\; \vec{u} = \partial_n = \vec{\xi}^h.$$

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Some aspects of mass-energy equivalence which appears in left handed metamaterials

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Metamaterials, artificial composite structures that are exhibit unusual properties, especially negative refractive index. Metamaterials with a negative refractive index are available since the 2000s [1], the main properties of which were described by V. Veselago in 1967 [2]. With the introduction the concept of negative refraction, there was a question how should be change the formulas which contains a refractive index n. Moreover, can we expect a correct result when straightforwardly replacing n to $-n$ in these formulas? In particular, Fresnel equations, Brewster law should be modified for getting exact formula. More detailed discussion of this topic done in [3].

If $n < 0$, it means that the phase and group velocities of electromagnetic waves are antiparallel in this media. In other words, the wave vector **k** and Poynting vector **S** are directed antiparallel to each other. So, there is a question about well-known formula $P = hk$, which relates linear momentum P and wave vector k of photon. Is it valid this formula for negative k? If yes, then it means that light absorbed or reflected inside medium with negative refractive index, should produce not a pressure, but attraction [4]. This problem is related with the problem of transferring energy, linear momentum and mass as the photon propagates in the medium.

In particular, mass-energy equivalence equation $\mathrm{E} = \mathrm{mc}^2$ assumes that if the space between the emitter and receiver is vacuum, then the transfer of electromagnetic radiation with energy E from emitter to receiver is accompanied by the transfer of mass m equal to $\mathrm{m} = \frac{\mathrm{E}}{\mathrm{c}^2}$. This equation is a direct result of special relativity theory. In 1906 Einstein repeat a derivation of mass-energy equivalence equation by his thought experiment, which known now as "Einstein box" (or photon in a box). Subsequently there was many modifications of this thought experiment.

In this work derivation of equation of mass-energy equivalence $E = mc^2$ is repeated in medium following to "Einstein box" thought experiment in, the so called A.P. French's "unhinged box" modification [5] and it is taken into account that phase and group velocities of radiation in medium differs from the speed of light in the vacuum c. Considering these conditions it is shown that c^2 in this equation have a definite physical meaning: exactly, one of c is phase velocity and the other one is group velocity. So, the equation of mass-energy equivalence should be written as

$E = mv_{ph}v_{gr}$ in common case, where v_{ph} - phase velocity, v_{gr} - group velocity. Perhaps, the more interesting question is the following: “How energy and mass are transferred as the photon propagates in the material with negative refractive index?”. According to equation $E = mv_{ph}v_{gr}$ there is a statement which strong enough and strange: due to opposition of phase and group velocities in medium with negative refractive index, radiation transfers the mass not from the emitter to receiver as usually, but rather from the receiver to the emitter. These problems is related to the concept of mass-energy equivalence in negative refractive index medium and discussed in [4], [6-7]

It is possible to simplify Einstein box thought experiment by “forgetting” about the receiver and “decreasing” the emitter to one atom following to A. Antippa’s “liberated photon” modification [8]. Using this simplification and assuming that all previous statements are correct, it can be argued that, when atom radiates photon in medium with negative refractive index, because of the opposition of phase and group velocities, photon transfers the mass not from an atom, but to an atom. The main attention is paid in this paper to the discussion of this simplest case.

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Cosmological model in van der Waals fluid

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The universe modeled with anisotropic space time and van der Waals fluid approximation, where the van der Waals fluid equation of state contains a single parameter ω_v in general relativity. Analytical solutions to the Einstein's field equations are obtained by assuming the mean scale factor of the metric follows volumetric exponential and power-law expansions. The model describes a rapid expansion where the acceleration grows in an exponential way and the van der Waals

fluid behaves like inflation for an initial epoch of the universe. Also the model describes, when time goes away the acceleration is positive, but it decreases to zero and the van der Waals fluid approximation behaves like a present accelerated phase of the universe. In this study, we found two interesting cases for$\omega_\nu < \frac{2}{3}$ and $\omega_\nu = \frac{2}{3}$ under the assumptions of volumetric exponential expansions only. For $\omega_\nu < \frac{2}{3}$ the analytical solutions of the model describes an inflation followed by radiation dominated era while for $\omega_\nu = \frac{2}{3}$ describes an inflation followed by a matter dominated epoch. It is observed that the pressure p_ν is growing slowly with negative value from the initial epoch and suddenly rise into negative infinity for some finite values of 't' and the energy density p_ν is growing slowly with positive value form the initial epoch and suddenly rise into positive infinity for some finite value of 't' and the mean scale factor $a \to a_f$ (where a_f is finite) as $t \to t_f$ (where t_f is finite), which indicates that the model contain type-III future singularity.

To the question of a common field theory

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From the basic physical reasoning the modelling gravitation theory is build. This theory is alternative to the Hilbert – Einstein theory. There is one adjusting parameter of the theory it's length dimension L_G. It's analytically proofed that $L_G = \frac{e}{c^2}\sqrt{G} \sim 10^{-34} cm$,where e - is charge of electron, G - is the gravitation constant, c - is the light velocity. It's shown that from the proposal theory we can get all fundamental conclusion of Relativistic Theory of Gravitation. In particularity the gravitation waves, Newton's potential and so on. It's demonstrated that at neglecting by interactions between all fields we are getting of a separate equations for four-dimensional electromagnetic field potential, relativistic equation for the gravitation potential, and also heterogeneous equation of Dalambert for the potentials of the both great interaction and the Dark matter. The note is a consequent of fifth dimensional space where the role of five dimension are play the field of physical nature, but not the scale as in the "M-theory". We have consider the five dimensional space, where the role of five dimension play fields of the physical nature. The basic value is displacement $\vec{\xi} = (\xi_1^i, \xi_2, \xi_3, \xi_4)$ from equilibrium behavior. Main functional of the problem is full potential energy of curve continuum as $U_4 = B_4 \int_{\Sigma_\Omega} R d\Sigma_\Omega$, where R - is a Ryman's curvature. The hypersurface element are the $d\Sigma_\Omega = \sqrt{-g} dx^1 dx^2 dx^3 dx^0$ and metrics is a following

$ds_5^2 = c^2dt^2 - dx^2 - dy^2 - dz^2 - d\vec{\xi}^2$. After all calculations we have such equation of the theory.

$$\square^2\xi^\alpha - \kappa^2\xi^\alpha = -L_G^2\frac{\pi kG}{c^2}f^\alpha + B_{\beta\gamma\delta}^{\alpha ijklmn}\frac{\partial}{\partial x^i}(\xi_{x^j}^\beta\xi_{x^kx^l}^\gamma\xi_{x^nx^m}^\delta) \qquad (1)$$

Where $B_{\beta\gamma\delta}^{\alpha ijklmn}$ is a dimensionless tensor of six rang, which account all interactions between known fields physical nature. f^α is a force of per volume acting on the hyper - membrane. See [1–4].

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К вопросу о единой теории поля

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Исходя из общих физических рассуждений, предлагается модельная теория гравитации, не идущая вразрез с общепринятыми идеями, но являющаяся альтернативной по отношении к классической теории Гильберта – Эйнштейна и квантовой "М-теории". С ее помощью выводятся обобщенные полевые уравнения, описывающие, в частности, гравитационное, электромагнитное и сильные поля при помощи единственного подгоночного параметра, имеющего размерность длины L_G. Показано что из предложенной теории также следуют все основные выводы ОТО, в частности, гравитационные волны, потенциал Ньютона и другие. Аналитически доказано, что $L_G = \frac{e}{c^2}\sqrt{G}\sim 10^{-34}cm$, где e - заряд электрона, G - гравитационная постоянная, c -+ скорость света. Продемонстрировано, что в пренебрежении взаимодействием между всеми полями получаются отдельно уравнения на четырехмерный потенциал электромагнитного поля, релятивистское уравнение для гравитационного потенциала, а также неоднородное уравнение Даламбера для потенциала сильного взаимодействия и "Темной материи". Отмеченное является следствием введенного в рассмотрение пятимерного пространства,

в котором роль пятого векторного измерения играют все известные физические поля. Основным функциональным параметром теории является векторная функция $\vec{\xi} = (\xi_1^i, \xi_2, \xi_3, \xi_4)$, описывающая отклонение поверхности гипермембраны пятимерного пространства. Благодаря предложенному в [3] обоснованию, элемент метрики может быть записан в виде

$$ds_5^2 = c^2dt^2 - k^{-2}(dx^1)^2 - k^{-2}(dx^2)^2 - k^{-2}(dx^3)^2 - d\vec{\xi}^2$$

где коэффициент k автоматически учитывает переход от макроскопических размеров к меньшим, и представляет собой масштабный множитель. По своему смыслу вектор $\vec{\xi}$ учитывает взаимодействие между разными физическими полями, и для него получается уравнение вида

$$\square^2\xi^\alpha - \kappa^2\xi^\alpha = -L_G^2\frac{\pi k G}{c^2}f^\alpha + B_{\beta\gamma\delta}^{\alpha ijklmn}\frac{\partial}{\partial x^i}(\xi_{x^j}^\beta \xi_{x^k x^l}^\gamma \xi_{x^n x^m}^\delta) \qquad (1)$$

где $B_{\beta\gamma\delta}^{\alpha ijklmn}$ - точно вычисляемый безразмерный тензор 6-го ранга, а нижние индексы у ξ^α означают частные производные по соответствующему аргументу, f^α - обобщенная объемная сила. Тензор $\hat{B}$ учитывает все упомянутые взаимодействия. Это уравнение получено из условия минимума полной поверхностной энергии гипермембраны, найденное благодаря метрике ds_5 (см.[1–4]).

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Effects of moving media optics in GLONASS optical segment of new generation

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The main element of the GLONASS optical segment is the microsatellite in the form of Luneberg lens, which should provide calibration of the global navigation system at a millimeter level of accuracy.

To model this segment, we constructed a mathematical model with allowance for the effects of the moving media optics (Doppler effect, Fizeau effect, Snell's law violation); the multipath nature of the interference response; dispersion.

The propagation of an electromagnetic wave in the medium is considered as a set of layers having dielectric permeabilities ε_i and separated surfacesP_i. Each interface between the two adjacent media can have a normal velocity component $V_i(t)$. On each media interface there occur a refracted and reflected wave. To find the frequencies and wave vectors in media, dispersion equations are used for each medium.

The parameters of the medium can depend on the parameters of the radiation passing through it, therefore, before each media interface, it is necessary to perform a recalculation $n = \sqrt{\mu\varepsilon}$ depending on the wavelength.

To find the frequency of an electromagnetic wave at each step of the calculation, it is enough to solve a dispersion equation for a constant n, then calculate $n(\omega)$ for the given solution, apply a new value of the refractive index to the dispersion equation and repeat the process to ensure the convergence of the solution.

The intensity distribution in the observation plane of the interference pattern depends on the number of rays from the total number N falling into each coordinate interval.

We built a recurrent system that allows the calculation of the ray path in a moving Luneberg lens and also construction of the intensity distribution in the observation plane of the multipath interference pattern.

The linear velocity of the satellite has a little effect on the ray intensity distribution at small incidence angles on the lens, which form a signal in the receiving region. However, the speed significantly changes the ray intensity distribution having a large incidence angle and, on the whole, significantly attenuates the signal because of the intensity redistribution.

The change in the geometric characteristics of the satellite essentially affects the intensity distribution. Rotation of the satellite also changes the satellite intensity distribution [1-2].

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The basic principles of building an analytics platform for the search of new scientific knowledge

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The global development of information resources, the increased speed of obtaining and accumulating information in various fields of knowledge resulted in the need to analyze large amounts of data and to automate the extraction of previously unknown knowledge from this data. In particular, gravitational-wave astronomy became possible due to accumulating and processing large experimental data.

The existing system for assessing scientific results and projects is based on indirect evidence (for example, the article citation, or the impact factor of the journal) and does not take into account the dynamics of their change. This leads to the need to develop dynamic scientometric indicators, in the form of vector potentiall $\overrightarrow{N_i}(t)$.

It is also necessary to systematically evaluate the obtained scientific knowledge (theoretical or experimental result, etc.) and assign a unique digital code to it that would allow scientific knowledge classification.

The basic work is a source of new knowledge, therefore the estimation of its importance can be defined by the new knowledge flow divergence $\overrightarrow{Z_i}(t)$. The field is a vector field, as each new scientific work is characterized by a vector in the space of scientific knowledge.

Also, the priority assessment of the scientific task $\overrightarrow{P_i}(t)$ depends on time, which is an important factor in determining the feasibility of supporting a particular study.

The progress in science can be defined as a non-zero vector of development $\overrightarrow{R_i}(t)$. However, the presence of development or progress does not ensure a breakthrough, intermittent growth of scientific knowledge, this requires a mutually reinforcing influence of various factors.

Obviously, the expectation of a breakthrough in a particular field of knowledge should be determined not by an additive but by a multiplicative law, including the new knowledge flow divergence $\overrightarrow{Z_i}(t)$, the priority assessment $\overrightarrow{P_i}(t)$ and the scientometric vector potential $\overrightarrow{N_i}(t)$.

Thus, a possible breakthrough is predicted by the superposition or intersection of the three vector fields.

In general, the analysis leads to the conclusion that significant progress in the field of science development will occur when an information and analytical system based on four fundamental elements is introduced. The elements include: extension of the standard set of scientometric indicators, introduction of dynamic indicators; introduction of a universal classifier of scientific knowledge; formation of a priority

task database; creation of an algorithm for estimating the feasibility and forecasting the breakthrough.

Accumulation of multiple-beam Fabry-Perot phase response interferometer based on Fizeau effect

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The study proposes a method for controlling the laser radiation wavefront phase in a ring resonator based on Fizeau effect.

The laser ring resonator is an optical resonator where two independent oppositely directed traveling waves are generated. Frequencies of traveling waves depend on the ring resonator rotating in the inertial space.

Harmonic control of electromagnetic waves phase in the resonator can be implemented, for example, by vibrations of two plane-parallel transparent prisms placed on the laser beam path, so that the oscillatory motion occurs parallel to the direction of light propagation.

In this work, we estimate the magnitude of the interference shift occurring during one half-period of the prisms oscillations.

The efficiency of dragging light by a moving medium depends on the product $\chi = (n^2 - 1)l_0 V$, where l_0 is the geometric length of the path traversed by the laser beam in the medium, and V is the linear velocity of the displacement (in the projection onto the beam). The speed of the prisms is small in relation to the speed of light, which allows light waves propagating along a closed contour to make a certain effective number *i* of passes through the optical medium in half-period $T_{1/2} = \frac{1}{2f}$.

The described scheme can be used in ring laser gyroscopes of the spacecraft orientation systems, as well as in laser interferometers for recording gravitational waves, as well as in the problem of recording ultra-small shifts.

The use of low-frequency optical resonance to increase the signal-to-noise ratio in a multibeam Fabry-Perot resonator (FP resonator) was proposed in [1]. The authors showed that one of the possible ways to improve the reception efficiency of a weak quasiharmonic signal is the harmonic control of the initial phase of the electromagnetic wave $\varphi_0(t)$ at the frequency of the expected signal. It follows from the above estimates that the ring scheme of the resonator can be proposed for the accumulation of the amplitude of the phase shift of the electromagnetic wave at the input to the FP resonator in the problem of recording gravitational waves.

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Generation and detection of high-frequency gravitational waves at intensive external excitation

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The talk is devoted to the problem of establishing conditions for the generation and detection of high-frequency gravitational waves in two-photon excitation of material media. The possibility of realization of such processes, called parametric, was predicted by M.E. Gertsenshtein and V.I. Pustovoit in 1962 [1]. The essence of the method is based on the two-photon absorption of intense electromagnetic radiation by material medium. The propagation velocity of the electromagnetic radiation absorbed due to the two-photon process should be close to the propagation velocity of a gravitational wave. Generation of high-frequency gravitational waves in parametric process can be realized in the stars, in particular inside the Sun, due to the high intensity of the corresponding electromagnetic radiation.

Detection of the such gravitational radiation can be performed under terrestrial conditions by analyzing the electromagnetic radiation spectrum at the frequency of third optical harmonic of star radiation, the basic harmonic which corresponds to the maximum spectral intensity of analyzed star. Frequency tripling process is carried out due to the anti-Stokes Raman scattering of the one-photon (excitation) radiation with two-photon state of the material medium, as a result of which the frequencies will be addition. An important advantage of the high-frequency gravitational waves parametric detection process, compared with the known method based on the detection of low frequency (10-100 Hz) mechanical oscillations of stars, the factor is the sixth power of the frequency in the formula for gravitational radiation intensity.

Another possibility of detecting of high-frequency gravitational waves is based on the using of intense pulsed laser light sources as an exciting radiation to detect triple frequency radiation in dielectric media and photonic crystals. It is supposed to use lasers, providing the ability to generate ultrashort (pikosecond and femtosecond) light pulses with wavelengths in the region of one micron or 0.5 micron, which corresponds to the optical visible or ultraviolet range of the third harmonic, convenient for recording sensitive radiation receivers.

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Applications of paramagnetics for photon-axion conversion

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The possibility of realization of a photon-axion and axion-photon conversion processes in transparent dielectric media within the visible frequency region is analyzed. Materials contain paramagnetic ions with large magnetic moment: Tb3 +, Eu3 +, etc. Therefore an additional strong magnetic field is present in the region of the paramagnetic ion. The reinforced field provides increased probability of the conversion processes. In order to ensure the synchronism condition it is supposed to use laser radiation whose frequency coincides with the frequency of unitary polaritons with a refractive index equals to one. Schemes akin the known scheme “Light Shining through a Wall” can be used to observe the photon-axion conversion process. The estimation of efficiency of conversion processes using real sources of laser radiation and the specific dielectric media with paramagnetic ions is given

Использование парамагнитных сред для фотон-аксионной конверсии

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Анализируется возможность реализации процессов фотон-аксионной и аксион-фотоной конверсии в прозрачных в видимой области спектра диэлектрических средах, содержащих парамагнитные ионы с большим магнитным моментом: Tb3+, Eu3+ и др. При этом в области парамагнитного иона присутствует сильное магнитное поле, обеспечивающее повышение вероятности процессов конверсии. Для обеспечения условий синхронизма предполагается использование лазерного излучения, частота которого совпадает с частотой унитарных поляритонов с показателем преломления, равным единице. Для наблюдения процесса фотон-аксионной конверсии может быть использованы схемы, аналогичные известной схеме “Light Shining

Through a Wall”. Выполнены оценки эффективности процессов конверсии при использовании реальных источников лазерного излучения и конкретных диэлектрических сред с парамагнитными ионами

A geometrothermodynamics of gravitating system with axially symmetric metric

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A theory of first-order phase transition in contact statistical manifold is proposed to describe interface systems. The theory has not limitations of know Van der Waals-like phase transition theories. Based on this approach a geometrothermodynamics of gravitating systems with axially symmetric metrics is investigated. It has been shown that such geometrothermodynamics occurs in space-time with Newman–Unti–Tamburino-like metric.

To date, there are known some important experimental facts in cosmology: a nonlinear dependence of galaxies recession on magnitude of red shift, a nonlinear dependence of supernova luminosity on the red shift, gravitational lensing of galaxies which does not associated with fluctuations, existence of voids in the galaxies distribution [1]. Gravitating matter in regions expanded at an accelerating rate does not interact (or interacts weakly) with ordinary substance and is known as dark matter. The universe is a flat one, and therefore vacuum energy cosmological constant Λ has to be nonzero, and the Λ-term within Einstein equations describes the dark energy (see, for example, [2] and references therein] which can be interpreted as a fluid with negative pressure. The pressure takes on a negative value at first-order phase transition while the matter is in a metastable state. It was proposed in [3-4] to use the thermodynamics at gravity modeling. ΛCDM (Lambda cold dark matter) cosmological models [5] and electrically charged AdS (anti de Sitter) black holes [6] exhibit a liquid-gas like first order phase transition culminating in critical points that resemble the phase diagram of a Van der Waals fluid. We propose a theory of first-order phase transition in contact statistical manifold that describes interface systems and has not limitations which are in the Van der Waals-like phase transition theories [7]. The triad $\{\vec{r}, \frac{\partial \vec{r}}{\partial s}, \frac{\partial t}{\partial s}\}$ for space-time (r, t) defines our contact manifold which is called the thermodynamic phase space $\mathcal{T}$. The bundle $\mathcal{T}$ includes the four-dimensional space of the two pairs $\{\vec{r}, \vec{r_t}\}$ and admits a non-trivial connection determined by a Reeb vector $\frac{\partial}{\partial s}$. Utilizing this approach we study the geometrothermodynamics of gravitating systems with axially symmetric metric which is similar to Newman–Unti–Tamburino one.

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Confirmation of SR, GR and GW by Experiments

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In the past century physicists believed that the motion of small charges in an electromagnetic field, the null result of the Michelson – Morley type experiments and the advance of the perihelion of Mercury could not be explained from classical physics of Newton and Maxwell. They were mostly unanimous in the opinion that all those phenomena could only be explained from SR and GR. Therefore, they felt that the primary task of the physicists was then to design and to perform experiments that proved the superiority of SR and GR over classical physics. In 1938 Ives and Stilwell designed and performed an experiment that proved transverse Doppler Effect which was believed to be an SR effect. Bailey et al of CERN in 1977 designed and performed an experiment that proved that life-spans of radioactive particles increases with velocity which too was believed to be an SR effect. In 1919 bending of light rays grazing the surface of the Sun was measured and the result seemed to support the prediction from GR. In 1964 Shapiro time delay was measured. It too was in close proximity with GR prediction. In the present century NASA has measured the de Sitter and Lense-Thirring precessions of gyroscopes orbiting the Earth's polar orbit. NASA thinks that the precessions of those orbiting gyroscopes as measured are in conformity with GR predictions. GW was so far illusive. In 2016 LIGO experimenters have declared that they detected GW on the 14th September 2015 at 09:50:45 UTC.

In this report we have first pointed out that SR electrodynamics is nothing but the point charge classical electrodynamics of Oliver Heaviside. Then we have stressed that electric fields, electric charges and electromagnetic energy possess momenta and energies that we could experience with our sense organs. Therefore, these are real physical entities, i.e., objects. All objects are subject to gravitation. These electromagnetic entities should, therefore, similarly be subject to gravitation. Physical objects are carried with Earth at the vicinity of its surface and they experience Coriolis force while in motion. Electromagnetic entities should similarly be carried with Earth at the vicinity of its surface and they should experience Coriolis force while in motion with respect to the Earth's surface. From this simple classical consideration, we have shown that the phenomena viewed as SR and GR phenomena are actually classical phenomena. Therefore, confirmation and reconfirmation of those phenomena by experiments equally uphold classical physics of Newton and Maxwell. Therefore, we argue that SR and GR have not been confirmed by proper experiments.

LIGO authorities have recently claimed that some small sudden electromagnetic disturbances recorded in their Michelson- interferometers are the foot prints of GW. Why? Because, these disturbances match with the wave-form predicted by GR for inspiral and merger of a pair of black holes (having masses $36^{+5}_{-4}M_{\odot}$ and $29^{+4}_{-4}M_{\odot}$ respectively and the ringdown of the resulting single black hole (having mass $62^{+4}_{-4}M_{\odot}$ and gravitational radiation of $3^{+0.5}_{-0.5}M_{\odot}\ c^2$) within a fraction of a second 1.3 billion years ago. If the experimenters could get other wave forms with other strains, they could easily fit it with other hypothetical processes sanctioned by GR. Therefore, data matching with a hypothetical merger does not prove anything. In the given data for the masses of the black holes, mass variation is very high which, too, indicates wishful matching. Matching suggests to speculate, not to conclude.

The actual experiment shows that the experimenters have detected - extremely small sudden puzzling electromagnetic disturbances in certain range simulteneously- in two sets of two long perpendicular Michelson interferometer tubes (separated by 3000 KM) directed towards the same direction. Other things are only wild speculations. There could be many such puzzling disturbances in the solar system and beyond the solar system. If LIGO could prove the so called so-so merger as they have described, then their GW may be a reality. As they have not proved the so-so merger independently, so their GW is only and only a speculation as it was before the 14th September 2015 at 09:50:45 UTC. Therefore, we point out that those analyses of LIGO experimenters to reach such an overenthusiastic conclusion lack in scientific rigour. Our study shows that neither SR, nor GR, nor GW has been verified by proper experiments.

Probabilities in the topos approach to branching space-time

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Category theory offers new ways of formulating physical theories and reveals fundamental relations between them. Recently a topos unified view-point was proposed both to relativistic and quantum physics [1] on the basis of Belnapian branching space-time [2]. Topos is a category of a special type which in many respects resembles the category of sets. The last one is a natural domain of classical Boolean logic. Topos suggests an extension of its natural logic to intuitionistic logic. Lack of infamous excluded middle rule is its most prominent feature. In some respects, the intuitionistic logic of topoi is a more natural instrument for classical physics (and for general relativity) than the Boolean logic. The so-called quantum logic is devoid of another important property of classical logic – distributivity. In the proposed topos approach both these generalized logics find their natural places. To an extent it is an attempt to develop `logical paradigm' in physics.

The Belnap's model of branching space-time, Multiverse C, is the set of events partially ordered by causal relations. All quantum alternatives (actualized as well as non-actualized outcomes of any measurement) pertain to the Multiverse. In the context of the proposed approach, associated to any event in the branching space-time is a local orthocomplemented lattice (logic) of 'physically reasonable' propositions made by a localized observer. Orthologics are known as so-termed minimal quantum logics. Elements of these local orthologics are special collections of what are termed Belnapian worlds (maximal upward causally directed subsets of events) which the local event belongs to. The rule by which to any event e of the Multiverse the set Loc_e of all worlds including this event is associated is the object Loc of the main topos – the category of all contravariant functors (presheaves) from C to the category Set. In the ordinary quantum setting, the counterpart of any local orthologic is the lattice of subspaces of Hilbert space of the observer's environment. These subspaces are known to be orthoclosed and also closed as metric spaces in norm topology. Elements of local orthologics possess a similar closeness in two senses. The present work suggests a natural scheme of inserting truth probabilities of the 'physically reasonable' propositions into the topos framework. To this end, the concept of Chu spaces is used [3]. When applied to probabilities, the Chu space consists of a set of propositions, a set of hypothesis and a function of two variables which provides truth probability for a given proposition conditioned by an assumed hypothesis. The role of hypothesis for the state of environment in the topos approach is played by an element of local 'retrocausal' orthologic, i.e. orthologic in the Multiverse with the same set of events but opposite directions of all causal relations. The notion of orthogonality and topology are inserted into any local orthologic by means of a special object of the topos, the accessebility presheaf Acc. For any event Acc_e is an accessibility relation

for worlds from Loc_e. If this relation is equivalence, the law by which a probability Chu space is related to any event is a functor from the branching space-time to the category of all Chu spaces. This fact is of paramount importance for modeling reasonable behavior of a localized observer in the branching Multiverse. Bayesian inference is the main instrument of our every-day survival [4]. An important theorem is presented on category nature of Bayesian reassessment of hypothesis likelihood made by the local observer. The result is important in its own right.

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Rational Thinking and Reasonable Thinking in Physics: The Einstein's Relativity Theory as achievement of reasonable thinking

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The usual concept of space and time, based on Aristotle's principle of contemplation of the world and of the absoluteness of time, is a product of rational thinking. At the same time, in philosophy, rational thinking differs from reasonable thinking; the aim of logic is to distinguish finite forms from infinite forms. Agreeing that space and time are things of infinity in this work, we shall show that, with regard to these two things, it is necessary to apply reasonable thinking. Spaces with non-Euclidean geometry, for example Riemannian and Finslerian spaces, in particular, the space of the General Theory of the Relativity (four-dimensional pseudo-Riemannian geometry) and also the concept of multi-dimensional space-time are products of reasonable thinking. Consequently, modern physical experiment not dealing with daily occurrences (greater speeds than a low speed to the velocity of light, strong fields, singularities, etc.) can be covered only by reasonable thinking.

Two methods for a search of a magnetic monopole: a dynamic scheme – SQUID-magnetic calorimeter and a static scheme – SQUID-magnetostrictor

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The possibilities of two detection methods for a magnetic monopole search are considered. In the first one (the dynamical variant) the force acting on a magnetic charge from the side of the uniform magnetic field accelerates monopole, and in the second (static variant) it creates an additional stress in the fixed sample containing a monopole. In the first case, the system SQUID-paramagnetic calorimeter is used, and in the second - SQUID-magnetostrictor. According to estimates the necessary sensitivity is provided with a margin of several orders.

The Compact High Sensitive System SQUID - magnetostrictor: the Possibility of Developing a Phased Array for Gravitational Waves Registration

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SQUID-magnetostrictor is a high sensitive system capable to measure deviations of mechanical tension. Its high sensitivity is the consequence of uniting the high tensometric effectiveness of magnetostrictor sensor, acting on principles of the inverse magnetostrictive effect, based in its turn on the collective quantum solid-state effects on one hand, and on the other hand the high (on the quantum scale level) sensitivity of SQUID to the magnetic response of the sensor. This measuring system may find application in different fields but it seems to be rather promising as a gravitational waves detector. The reason is that the working magnetostrictive body serves as a receiving antenna sensitive to the deviations of the metric tensor $g_{ij}^{\perp}$ in the gravitational wave and converts it directly to the magnetic flux deviation detected by SQUID. Estimations of the sensitivity of such system consisting of the magnetostrictive cylinder (cross sectional area is $S = 30\ cm^2$, magnetostrictive constant is $\Lambda^{-1} = \frac{\partial B}{\partial p} \approx 7 * 10^{-6} T/Pa$ and Young modulus is $E = 100\ GPa$) and

SQUID with sensitivity $\langle\delta\Phi\rangle_{/\sqrt{Hz}} = \frac{10^{-6}\Phi_0}{\sqrt{Hz}} = 2{,}07 * 10^{-21} Wb/\sqrt{Hz}$ (where $\Phi_0 = \frac{\pi\hbar}{e} = 2{,}07 \times 10^{-15}\ Wb$ – magnetic flux quantum) give the value on the level of $\langle\delta P\rangle_{/\sqrt{Hz}} = 10^{-13}\ Pa/\sqrt{Hz}$ (P – mechanical pressure on the cylinder cross section) that corresponds to deviation of the transverse metric tensor component

$\left|\delta g_{ij}^{\perp}\right|/\sqrt{Hz} \approx 10^{-24}/\sqrt{Hz}$. (These estimations do not include possible losses due to a low coefficient of the flux transformer that could lower the result sensitivity for 2-3 orders). It can be noted the signal in the famous LIGO experiment was on the level of 10^{-21}. Additional advantage of the considered system is its compactness and lowcost. It permits to construct a phase array of n such detectors. Creation of phase array may enable both to determine the direction to the source of gravitational waves and to enhance the sensitivity in $\sqrt{n}$ times.

Instability states and ostrogradsky formalism

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The stability principle is a generalization of basic fundamental physical laws, such as least action principle, Newton's laws, Euler-Lagrange equations, Schrödinger equation, et al.

The stability principle may not only generalize, but also logically explain the basic laws of Nature. The stability enables using the stability of physical objects and their state for explanation and generalization of such fundamental Nature laws as the least action principle, stability of atoms, stationarity of possible trajectories, etc. It may be employed as a generalized law explaining such a fundamental Nature law as the least action principle. Therefore it can evidently be applied to all other laws following from the least action principle, such as Newton's laws, Euler-Lagrange equations, Schrödinger equation, laws of light and electromagnetic waves propagation, etc.

The state of a physical system is considered stable if it returns to its initial state after the action of external factors.

Applying this stability principle for the action function, we obtain:

$$|S, (q, \dot{q}, \ddot{q}, \dddot{q}, \dots, \dot{q}^{(n)}, \dots)^{\cdot} - S(q, \dot{q})| < H,$$

where random influences are described with higher time derivatives of generalized coordinates q and H is a some constant. In $S_r(q, \dot{q}, \ddot{q}, \dddot{q}, \dots, \dot{q}^{(n)}, \dots)^{\cdot}$ index r means the action function being described with the account of random influences.

Generalized Euler-Lagrange equations in Ostrogradsky formulation accounting for random influences in the form of higher derivatives will take on the form

$$\delta S = \delta \int L_r(q, \dot{q}, \ddot{q}, \dddot{q}, \dots, \dot{q}^{(n)}, \dots) dt = \int \sum_{n=0}^{N} (-1)^n \frac{d^n}{dt^n} \frac{dL_r}{drq^{(n)}} \delta r q^{(n)} \, dt = 0$$

The second Newton's law is a second-derivative differential equation describing stable dynamics. The instability dynamics with random influences shall be described with higher order differential equations with higher derivatives.

$$|\mathrm{F}, (q, \dot{q}, \ddot{q}, \dddot{q}, \dots, \dot{q}^{(n)}, \dots) \dot{-} F(q, \dot{q})| < H$$

Additional terms in the form of higher derivatives may play the role of hidden variables complementing both quantum and classic mechanics. Additional terms have non-local character, which enables their employment for description of nonlocal effects of quantum mechanics.

Нестабильные состояния и формализм Остроградского

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Принцип устойчивости – это обобщение основных фундаментальных физических законов, таких как принцип наименьшего действия, законы Ньютона, уравнения Эйлера-Лагранжа, уравнение Шредингера и др.

Принцип устойчивости может не только обобщать, но и логически объяснять основные законы природы. Принцип устойчивости позволяет использовать устойчивость физических объектов и их состояний для объяснения и обобщения таких фундаментальных законов природы, как принцип наименьшего действия, устойчивость атомов, стационарность возможных траекторий и т.д. Его можно использовать как обобщенный закон, объясняющий такой фундаментальный закон природы, как принцип наименьшего действия. Поэтому очевидно, его можно применить и ко всем другим законам, следующим из принципа наименьшего действия, к таким как законы Ньютона, уравнения Эйлера—Лагранжа, уравнения Шредингера, законы распространения света, электромагнитных волн и т. д.

Состояние физической системы будем называть устойчивым, если система возвращается в исходное состояние после воздействия внешних факторов.

Применяя этот принцип устойчивости для функции действия, получаем:

$$|S, (q, \dot{q}, \ddot{q}, \dddot{q}, \dots, \dot{q}^{(n)}, \dots) \dot{-} S(q, \dot{q})| < H \ ,$$

где малые случайные воздействия описываются высшими производными обобщенных координат q по времени, а H – некоторая константа. В

$S_r(q, \dot{q}, \ddot{q}, \dddot{q}, \dots, \dot{q}^{(n)}, \dots)$ индекс r означает функцию действия с учетом малых случайных воздействий.

Обобщенные уравнения Эйлера-Лагранжа в формулировке Остроградского, учитывающие случайные малые влияния в виде высших производных, будут иметь вид

$$\delta S = \delta \int L_r(q, \dot{q}, \ddot{q}, \dddot{q}, \dots, \dot{q}^{(n)}, \dots) dt = \int \sum_{n=0}^{N} (-1)^n \frac{d^n}{dt^n} \frac{dL_r}{drq^{(n)}} \delta r q^{(n)} \, dt = 0$$

Второй закон Ньютона – дифференциальное уравнение второй производной, описывающее устойчивую динамику. Неустойчивая динамика со случайными бесконечно малыми влияниями описывается дифференциальными уравнениями более высокого порядка с высшими производными.

$$|F, (q, \dot{q}, \ddot{q}, \dddot{q}, \dots, \dot{q}^{(n)}, \dots) - F(q, \dot{q})| < H$$

Дополнительные переменные в виде высших производных могут играть роль скрытых переменных, дополняющих как классическую, так и квантовую механику. Дополнительные термины имеют нелокальный характер, что позволяет использовать их для описания нелокальных эффектов квантовой механики.

Sakharov curvature in Rowlands duality spacetime

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It is well known that Einstein's theory of general relativity provides no insights into Mach's principle. Vigier called inertia an "unsolved mystery in modern physics." Einstein's general theory of relativity gives us a geometric description of spacetime structure, a theory "*about*" gravity, not a theory "*of*" gravity. For over a century the geometry of general relativity (GR) does not appear to be a suitable framework for describing behaviors at high energies. Quantum effects have undermined the ability to give valid geometric descriptions of spacetime. Quantum theoretical considerations impose fundamental limitations on the accuracy with which spacetime measurements can be made. It is not possible, for example, to approximate with arbitrary precision free test-point particles in which any spacetime structure is measured according to general relativity. Time considerations of quantum mechanical clocks also reveal fundamental limitations to measurements of duration as well as distance. The physical meaning given to spacetime points and manifoldshas been seriously questioned.

There have been many failed attempts at grand unification since quantum gravity was first introduced in the 1930s. Space, time, inertia, gravity, and electromagnetic forces have dominated the thinking of classical physicsts.Einstein's special and general theories of relativity showed that Galilean and Newtonian

theoriesare only approximations when objects moving at less than the speed of light are considered. The question on how to measure spacetime structure so that both quantum considerations and gravitational matters come under one theory is still open. The key to linkinggravitation to the behavior of subatomic particles and gauge forces seems to originateinAndrei Sakharov's1967 proposal that Newtonian gravity could be interpreted as a van der Waals force that emerges from the action of quantum fluctuations of the vacuum. Spacetime appears to bea phenomenon associated with the physics of particles and fields. Spacetime, however, is not directly observed. Its structure is deduced indirectly by looking at the propagation of radiation and matter. Spacetime structure may be actually encoded into the structure of the theory that is called quantumfield theory (QFT). Sakharov's approach to the "theory of gravitation is analogous to the discussion of quantum electrodynamics (QED)". Sakharov wrote "Рассматривается гипотеза, отождествляющая действие (в теории гравитации Эйнштейна) с изменением действия квантовых флуктуаций вакуума при искривлении пространства. "Translation:" The hypothesis that identifies the action (in Einstein's theory of gravity) is considered with the change in the action of quantum fluctuations of vacuum in the distortion of space. Sakharov obtains an expression for the Newton's gravitational constant G that is also used in Einstein's field equation. The expression Sakharov derives $G = \frac{c^3 L^2}{h} = \frac{hc^3}{{p_0}^2}$ connects Newton's gravitational constant to the elementary Planck length L and a limiting momentum $p_0 = \frac{h}{L}$. He applies this limit as the cutoff length of Einstein's action.

Einstein's theory of gravity leads to a QFT which cannot be normalized by standard quantization methods. An increasing number of singularities are encountered when spacetime is curved. Sakharov's idea is that the gravitational phenomenonis induced by particle interactions in the "metrical elasticity of space" which opposes the curving of spacetime. It is known that the quantum vacuum makes a contribution to inertial mass. Part of the inertial force of opposition to acceleration, the inertial reaction force, originates in the zero-point fluctuations (ZPF) of the quantum vacuum. The existence of an energy-momentum flux as experienced in a Rindler constant acceleration frame and the Unruh-Davies radiation both emerge from event-horizon effects in accelerating reference frames. The force of radiation pressure produced by the Rindler flux is proportional to the acceleration of the reference frame. The hypothesis that the inertia of an object is due to the individual and collective interaction of its quarks and electrons with the energy momentum flux allows for a new interpretation of Sakharov's conjecture about the elasticity of spacetime. If we regard the inertial reaction forces as being emergent from vacuum fluctuations the elasticity of spacetime, the resistance to gravity, may be considered as the origin of inertial mass while simultaneously giving quantum spacetime its curvature. Vacuum energy, according to Sakharov, cannot generate a gravitational field but it can generate an inertial field. These considerations naturally lead to the following conclusions(1) Planck length spacetimeinertial reaction forces are created by vacuum fluctuations, (2) the inertial forces are responsible for curvature, and (3) the gauge forces are brought into balance bya continuous gravitational field. The third

conclusion candeducedas an application of Rowlands' zero-totality condition and conjecture that it is discrete inertial forces that are amenable to quantization which result in the emergence of a continuous gravitational field that balances the gauge forces. Rowlands' discrete gauge/continuous gravity space/anti-space duality may be regarded as a conservation law analogous to a continuous kinetic/discrete potential energy conservation law. Before the popularity of string theory Sakharov anticipated, in 1984, the compactification of extra space and time dimensions. String theorists agree that there are many distinct ways, practically 10^{500}, ways of turning 9-D space into 3-D space by curling up6-D. Sakharov's ideas on compactified space is not the focus of this paper.

Braiding, Majorana Fermions and the Dirac Equation

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The simplest discrete system corresponds directly to the square root of minus one, when the square root of minus one is seen as an oscillation between plus and minus one. This way thinking about the square root of minus one as an iterant is explained in the paper.

Iterant algebra generalizes matrix algebra and we shall see how it can be used to formulate the Clifford algebra for Majorana Fermions and representations of the Artin braid group associated with this algebra. The paper then turns to the construction of the Dirac equation and shows how nilpotent solutions to the Dirac equation arise naturally in this context and how they are related with Majorana Fermions.

On the quantum origin of the Lorentz group

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Our aim is to derive the symmetries of the space-time, i.e. the Lorentz transformations, from the discrete symmetries of interactions between the most fundamental constituents of matter, in particular quarks and leptons. We show how the discrete symmetries Z_2 and Z_3 combined with the superposition principle of quantum mechanics give rise to the emergent SL(2, C)-symmetry. The role of Pauli's exclusion principle in the derivation of this invariance group is put forward as the source of the macroscopically observed Lorentz symmetry Then Pauli's principle is

extended to the case of the cyclic group Z_3 generalizing the usual Z_2 symmetry, and ternary version of Dirac's equation in introduced to describe color dynamics. The unusual Z_3-graded representations of the Lorentz group are constructed, and the emergent character of Minkowskian space-time is illustrated on this example.

We then analyze the relationship between the three fundamental realms of physics, as perceived since the advent of modern science: the space-time continuum, the material bodies, and forces acting between them. The corresponding domains of physics are: the General Relativity describing the properties of the space-time manifold, Quantum Mechanics describing the behavior of atoms and nuclei of which material bodies are made, and the Field Theory (classical and quantum) describing fundamental forces and their propagation. Newtonian Mechanics and theory of gravity did not contain any notion of *fields*, being based on the absolute time and space, in which material bodies acted on each other at a distance and instantly. Faraday and Maxwell introduced the notion of contact action transmitted by aether, described by electromagnetic field. Einstein's dream was to eliminate the notion of elementary particles, and point-like massive bodies, replacing them by field singularities.

We shall present arguments in favor of the third possibility, namely the elimination of the space-time manifold from the above three realms, thus basing physics exclusively on the two remaining ones, i.e. elementary particles described by quantum mechanics and fields carrying interactions between those. Only conserved quantities such as energy-momentum four vectors, should serve as a basis for analysis of physical phenomena. The space and time appear then as emergent, whence the idea that also gravitation phenomena, as described by General Relativity, should be treated as emergent, too.

Radiation of particle in wormhole spacetime

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Wormholes are topological bridges which connect different universes or different parts of the same universe. The activity in wormhole physics was initiated by the classical paper by Einstein and Rosen [1], and later by Wheeler [2]. The most recent growth of interest in wormholes was connected with the ''time machine'', introduced by Morris, Thorne, and Yurtsever in Ref. [3]. Their works led to a surge of activity in wormhole physics [4]. It is well known that in flat Minkowsky spacetime, a uniformly moving charged particle does not produce electromagnetic radiation. In the framework of quantum electrodynamics, the bremsstrahlung process corresponds to the emission of radiation by a charged particle when it changes its momentum in collisions with obstacles such as other particles or when it is

accelerated due to the presence of electromagnetic fields. In curved spacetime, the situation is quite different – a uniformly moving charged particle produces radiation.

Uniform motion in curved spacetime is motion along the geodesic line. Aliev and Galtsov in Ref. [5] were the first to establish this effect in the context of cosmic strings. They calculated the total energy loss and its spectral density for particles moving on these lines. This classical result was reviewed and recovered in the framework of quantum field theory. The same approach was applied for a pointlike global monopole spacetime in Ref. [6].

We consider a particle with electric or scalar charge which is uniformly moving in the wormhole spacetime and calculate its total energy loss and spectral density of the energy. We take into account the simplest spherically symmetric wormhole with metric $ds^2 = -dt^2 + d\rho^2 + r^2(\rho)d\Omega$ considered by Bronnikov [7] and Ellis [8], where $d\Omega$ is the metric of the unit two-dimensional sphere and $t, \rho \in R$. The spacetime is divided into two parts in which $\rho > 0$ and $\rho < 0$. The function $r(\rho)$ describes the profile of the wormhole's throat. The radius of the throat, a, is defined as the minimum of this function at the point $\rho = 0$.

The total energy radiated by a particle throughout its lifetime reads

$$E = \int T^{\nu}_{\mu,\nu}\xi^{\mu}dx = 4\pi \iint G^{rad}_{\mu\nu'}J^{\mu}J^{\nu'}dxdx',$$

where $G^{rad} = \frac{G^{ret} - G^{adv}}{2}$ is the radiative Green function; and $T_{\mu\nu}$ is the energy-momentum tensor of the field, and ξ^{μ} is the timelike Killing vector of the spacetime. We obtained general form of the total energy loss and its spectrum in terms of the radial function and made calculations in details for wormhole with profile $r(\rho) = |\rho + a|$ and particle with electric charge. This model of profile was suggested in Ref. [9].

Main results: i) we show that the total energy loss $E \sim e^2 v\gamma\gamma^2/b^2$, where γ is relativistic factor, a is the radius of the wormhole's throat, and b is the impact factor and v is the velocity of particle, ii) the spectrum of the energy for particles radially moving through the wormhole's throat is $E \sim e^2 v\gamma/a$, iii) the spectral density of the total energy has a maximum at frequency $\omega_m \sim v\gamma/b$ and at $\omega_m \sim v\gamma/a$ for radial motion.

The results obtained is useful in astrophysics for observation wormhole in Universe.

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Stable cosmological wormholes

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We describe in details the procedure how the Lobachevsky space can be factorized to a space of the constant negative curvature filled with a gas of wormholes. We show that such wormholes have throat sections in the form of tori and are traversable and stable in the cosmological context. The relation of such wormholes to the dark matter phenomenon is briefly described. We also discuss the possibility of the existence of analogous factorizations for all types of homogeneous spaces. We also present some simple tests which allow the search for such objects in observations.

Устойчивые космологические кротовые норы

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Предложена процедура, посредством которой пространство Лобачевского факторизуется до пространства постоянной отрицательной кривизны содержащее произвольное количество кротовых нор. Показано, что подобные кротовые норы имеют горловины в форме торов, являются проходимыми и устойчивыми в космологическом контексте, т.е., их характерное время эволюции сравнимо с возрастом Вселенной. Обсуждается роль подобных кротовых нор в возможном объяснении феномена темной материи. Обсуждается проблема существования подобной факторизации для всех типов однородных пространств. Предложены простейшие тесты, позволяющие выделить подобные объекты (устойчивые кротовые норы) из наблюдательных данных.

Review on Absolute Velocities - Suggested Modifications in Relativity

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A precise definition of 'inertial frame of reference' explained that the special relativity is not a relevant theory for any observable events in this universe. All the observations in this universe involved with consciousness. 'Film theory of the universe' explained the interaction between two films connected by consciousness. Thus It emphasized that there will not exist ideal 'inertial frames' in this universe and explained that all the frames are accelerated frames only. 'Double relativity Effect' was applied to explain these accelerated frames. The concept of 'absolute velocities' emphasizes the importance of observation with the application of consciousness and the physics behind it. It says that all the observed velocities are associated with absolute velocities. Absolute velocities and observed velocities related by an equation $v_o = v_a\ \gamma$.when it is applicable to 'Film theory of the universe', a film is explained by an Inertial frame of reference. The concept of consciousness and 'Super theory of relativity' explains the transformation between two films. Thus new concept of absolute velocities introduced.

The review of these new concepts will form an integrated out look of a new generation physics which will be helpful for the development of physics of origin of universe, theories of gravitation, calculation of dark matter and physics of consciousness.

Macroscopic entanglement and time reversal causality by data of the Baikal Experiment

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Although the general theory macroscopic quantum entanglement is still in its infancy, consideration of the matter in the framework of action-at-a distance electrodynamics predicts for the random dissipative processes observability of the

advanced nonlocal correlations through timelike interval (that is time reversal causality, which is allowed by the quantum principle of weak causality in the uncontrolled entangled states). Moreover, action-at-a distance electrodynamics predicts that the advanced component of nonlocal correlation can exceed the retarded one. The propagation velocity for diffusion entanglement swapping through a medium can be very small. Accordingly, the retardation and advancement can be very large. In addition, if the correlation asymmetry is not too large, the third, apparent instantaneous (quasi-synchronous) correlation maximum may exist because of advanced/retarded signal interference. Such correlations were really revealed in our previous experiments with some large-scale random heliogeophysical processes as the source ones and the lab detectors as the probe ones. However, the strongest macroscopic nonlocal correlations are observed at extremely low frequencies (at periods of order of several months); therefore, the long-terms experiments, therewith under very stable conditions in the detectors, are necessary. It is difficult to achieve in a usual laboratory. To overcome this difficulty, a new experiment is conducting on the base of Baikal Deep Sea Neutrino Observatory. Baikal thick water layer is an excellent shield against any local impacts on the detectors. The Baikal experiment aims, first, study of nonlocal correlations between the electrode detectors at different horizons in the lake and spaced at 4200 km one in the land laboratory, and second, study of correlations between the detector signals and large-scale natural dissipative processes with big random components. Data were processed by the methods of spectral, correlation and causal analysis. The several annual series of measurements, obtained since 2012, demonstrated that the detector signals respond to the random heliogeophysical (global) processes and causal connection of the signals directed downwards: from the Earth surface to the Baikal floor. However, this nonlocal causal connection proved to contain considerable time reversal component, in all cases exceeding the retarded one. This excess depends on the mass of the absorbing medium separating the nonlocally correlating processes; under the conditions of this experiment, the maximum ratio of the observed time reversal and time respecting (normal) causality functions reaches 2.1. In the cases, when this ratio, on the contrary, slightly exceeds one, the quasi-synchronous causality maximum is also observed. Therewith nonlocal nature of observed correlations has been confirmed by violation of the steering inequality with combination of solar and geomagnetic source-processes. The amount of advancement (and corresponding retardation) of the detector signal with respect to these global processes is of the order of hundreds of days, while between detectors at different horizons in the water column it is of tens of days. Next, advanced, for a time of the order of tens of days, nonlocal correlation of the detector signal with the regional source-process: the random component of hydro-thermodynamics activity (macroturbulence) in the upper layer of the lake, was revealed and the possibility of the forecast of temperature and sea current random variations on nonlocal correlations was demonstrated. An important result has been displaying of the advanced (up to 12 days) response of nonlocal correlation detector to the earthquake (clearly visible in the detector signal record without any processing). This opens up the prospect of the earthquake forecast on the new physical principle, although further confirmation in the next events is certainly

needed. In the current work, we use very long, four-year (2013-2017) time series of observations with a deep-sea detector to demonstrate properties of time reversal nonlocal causal connection of its signal and natural regional processes with big random component. The large length of the series has made it possible to significantly increase the reliability of estimates of low frequency nonlocal correlations. The continuation of the Baikal experiment with expanded program is burning.

Макроскопическая запутанность и обратно-временная причинность по данным Байкальского эксперимента

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Хотя общая теория макроскопической квантовой запутанности находится еще в зачаточном состоянии, рассмотрение проблемы в рамках абсорбционной электродинамики предсказывает для случайных диссипативных процессов наблюдаемость опережающих нелокальных корреляций через времениподобный интервал (обратно-временной причинности, которая разрешена квантовым принципом слабой причинности в неконтролируемых запутанных состояниях). Более того, абсорбционная электродинамика предсказывает, что опережающая компонента нелокальной корреляции может превышать запаздывающую. Скорость распространения при обмене запутыванием через среду может быть очень мала. Соответственно, времена запаздывания и опережении могут быть очень велики. Кроме того, если асимметрия корреляций не слишком велика, из-за интерференции опережающего/запаздывающего сигналов может существовать третий, кажущийся мгновенный (квазисинхронный) корреляционный максимум. Такие корреляции были действительно выявлены в наших предшествующих экспериментах с некоторыми крупномасштабными гелиогеофизическими процессами-источниками и пробными процессами в лабораторных детекторах. Но наиболее сильные макроскопические нелокальные корреляции наблюдаются на крайне низких частотах (на периодах порядка нескольких месяцев), поэтому необходимы длительные эксперименты при высокостабильных условиях в детекторах. Этого трудно достичь в обычной лаборатории. Для преодоления этой трудности проводится новый эксперимент на базе Байкальской

глубоководной нейтринной обсерватории. Мощный водный слой Байкала является хорошим экраном от любых локальных воздействий на детекторы. Целями Байкальского эксперимента является, во-первых, изучение нелокальных корреляций между электродными детекторами на различных горизонтах в озере и в удаленной на 4200 км наземной лаборатории. Данные обрабатывались методами спектрального, корреляционного и спектрального анализа. Несколько годовых серий наблюдений, полученных с 2012 г. показали, что сигналы детекторов откликаются на случайные гелиогеофизические (глобальные) процессы и причинная связь направлена сверху вниз: от земной поверхности к дну Байкала. Но эта нелокальная причинная связь содержит значительную обратно-временную компоненту, во всех случаях превышающую запаздывающую. Это превышение зависит от массы, разделяющей нелокально коррелирующих процессы поглощающей среды; в условиях данного эксперимента максимальное отношение наблюдаемой обратно-временной и прямо-временной (нормальной) функций причинности достигает 2.1. При этом нелокальная природа корреляций подтверждена нарушением неравенства стирингов с комбинацией солнечного и геомагнитного процессов-источников. Величина опережения (и соответствующего запаздывания) сигнала детекторов относительно этих глобальных процессов имеет порядок сотен суток, а между детекторами на различных горизонтах в водной толще – десятков суток. Далее, были выявлены опережающие, на время порядка десятков суток, нелокальные корреляции сигнала детектора со случайной компонентой гидротермодинамической активности (макротурбулентность) в верхнем слое озера и продемонстрирована возможность прогноза случайных вариаций температуры и скорости течения на основе нелокальных корреляций. Важным результатом является обнаружение опережающего (до 12 суток) отклика детектора нелокальных корреляций на землетрясение (ясно видимого в записи сигнала детектора без всякой обработки). Это открывает перспективу прогноза землетрясений на новом физическом принципе, хотя, естественно требуется подтверждение эффекта в следующих событиях. В настоящей работе мы используем весьма длительный, четырехлетний (2013-2017) непрерывный временной ряд наблюдений с глубоководным детектором для демонстрации свойств обратно-временной нелокальной причинной связи его сигнала с естественными региональными процессами с большой случайной компонентой. Большая длина ряда позволила значительно увеличить надежность оценок низкочастотных нелокальных корреляций. Продолжение Байкальского эксперимента с расширяющейся программой представляется весьма перспективным.

“Ghosts” and the Big Bang theory

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We propose to use “ghosts” (unobservable zero-spin fermions) introduced in the quantum chromodynamics for the renormalizability of the theory in the cosmology. The “ghosts” utilization necessity in the Universe is connected with the possibility for an explanation of processes with an immense energy release. We shall rely on the Landau theory of the Fermi liquid in which it is offered to replace the consideration of strong interacting original particles on the consideration of the almost ideal gas of repeat quasi-particles. We shall consider “ghosts” (which’s are characterized by the $SU(2)$ symmetry) as original particles of the Universe Fermi liquid and all Universe observable particles as repeat quasi-particles of the given Fermi liquid. If observable particles are absent in the Universe, then we shall consider that the Fermi liquid entropy is minimal, so as to use the second principle of thermodynamics. The given symmetrical state of the Universe matter is unlikely can consider a stable state if only on account of fluctuations. So in the first phase as a result of fluctuations are appeared particles in the excited state (quarks and antiquarks, having the additional degrees of freedom), among “ghosts”, existing in the ground state. Quarks and antiquarks interact by gluons and have baryon charges. The entropy of the all Universe matter increased, that is the indication of the given process irreversibility.

As a result of an increase of freedom degrees (the appearance of quarks and antiquarks) the Universe temperature must be decreased so, that must goes the spontaneous breaking of symmetry with the freezing-out of freedom degrees for “ghosts” (the appearance of neutrinos and antineutrinos which’s are characterized by the $SU(2)$ symmetry and which’s may be considered as the ideal Fermi gas). Considering “ghosts” as original particles of a Universe matter the transition to leptons (neutrinos and antineutrinos) may be interpreted as the phase transition. The given process causes to the increase of the entropy too. At present quarks and antiquarks attend only in hadrons and black holes (inside quark bags). The description of the Universe matter in this form is subject to the quantum chromodynamics completely. We connect the cutoff parameter of quantum chromodynamics with the Fermi energy of “ghosts”. We obtain the natural physical interpretation of the cutoff parameter and also we obtain the physical justification of the lattice model. Note, that the transition to the infinity of cutoff parameter in the quantum chromodynamics is the natural transition for the general collection in the mathematical statistics (for the simplification of calculations). The given transition is the base for the use of Hausdorff spaces in the physical theory and in particular the use of Euclidean and pseudo-Euclidean spaces. In our opinion further it must take place Cooper pairing of noncharged leptons with a formation of a Bose liquid, which

must cause to the density reduction of original leptons and to the appearance of photons, fundamental massive vector bosons, charged leptons (lepton bags or lepton bubbles) and hadrons (bags with quarks having electric charges). It can use the Bardeen-Cooper-Schrieffer mechanism of the microscopic superconductivity theory for the explanation of the neutrino Cooper pairs formation the more so that there were particles (quarks and antiquarks) for this in the Universe. In the Universe standard model the given process, having an explosive behavior (Big Bang) was accompanied an immense energy emission. As a result of a Bose condensation it was showed the asymmetry of noncharged leptons relative to a polarization. Sterile neutrinos and sterile antineutrinos (nonobservable particles in processes of beta decay) turned out to be bigger than observable particles with the “regular” polarization. With this moment we can consider that the Universe matter is at the modern stage and “ghosts” will play the distinct role only in a description of hadrons. The main role goes to neutrinos and antineutrinos. We shall consider these particles as background particles. The physical properties of sterile neutrinos and sterile antineutrinos must define geometrical properties of the space-time just therefore. The quantization of observed particle charges is the direct verification of the existence of the Universe background particles (the space-time is not the connected space). Note that at present in the Universe it is possible goes the reverse process of the Bose liquid decay with a density increase for noncharged leptons and consequently with the increase of distances between galaxies (physical properties of sterile neutrinos and sterile antineutrinos define space-time geometrical properties), which is interpreted as the inflation (the effect of the Universe dark energy).

The appearance of photons (playing the role of standards in the relativity theory) caused to the domination of electromagnetic interactions in experimental data and to the scope for division of the all Universe matter into two subsystems (slow and rapid). The matter of the slow subsystem does not participate in electromagnetic interactions and plays the catalyst role of stochastic processes. As a result it can consider that the slow subsystem of the Universe matter is described by the space-time, having nontrivial properties. By this Einstein equations define the connection of geometrical parameters with parameters, characterizing matter physical properties. It may observe the matter of the slow subsystem by the matter of the rapid subsystem. As a result the particles of the rapid subsystem play the role of Brownian particles. They allow studying the properties of slow subsystem particles.

Non-stationary Noise Sources in an Optoacoustical Gravitational Antenna

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The antenna consists of an cylindrical acoustic resonator and optoelectronic registration scheme of its length variations. The Fabry-Perot resonator mirrors are attached to its top surfaces; locked mode frequency variations are subtly revealed. Real resolution of the measurer is determined by intrinsic LF noises of the laser. Those are stochastic frequency deviations and laser power fluctuations (LPF). Spectral density of deviations had been measured: $(S_y)^{1/2} \approx 4Hz/(Hz)^{1/2}$ at the antenna operating frequency of 1,3 kHz. This noise source is suppressed by stabilizing laser frequency applying a reference F-P interferometer; the GWA resonator just performs this function. For this reason the enlarged gain factor K_{OS} is required in this locked feedback circuit. The value $K_{OS} = 10^3$ at 1,3 kHz is implemented in the OGRAN installation, and calculated noise component is $(S_y)^{1/2} \approx 4 * 10^{-3} Hz/(Hz)^{1/2}$. The interferometer conversion factor $\frac{\delta x}{\delta \nu_R} = \frac{L_1}{\nu_R} = 0.7 * 10^{-12}\ cm/Hz$ gives the resolution forecast for the measurer: $x_{min} \approx 3 * 10^{-15}\ cm(\Delta f)^{1/2}$; this satisfactory corresponds to the test result, which had been published.

Laser frequency retuning and stabilization system is realized in Pound-Drever-Hall (PDH) technique. It uses RF phase modulation of laser radiation and forms a discrimination feature at the output of a synchronous detector (SD); laser frequency ν_L follows resonator intrinsic frequency $\nu_R(t)$. The second, discriminatory channel converts laser signal frequency variations into measurer output voltage variation on the slope of its discrimination feature.

LF laser power fluctuations in the noise budget are replaced by negligible RF LPF using modulation-demodulation technique. In the first view LF LPF do not penetrate into precision measurer. It could be contained in constant SD output voltage, since it is formed by laser power envelope which carries this noise variable component. A PDH scheme is a zero-indicator for difference $\nu_R - \nu_L$; that is, SD voltage is aspired to zero. However, a regular SD voltage component appears as a result of residual amplitude modulation (RAM) arising in an imperfect RF modulator. The typical value of the modulation depth m_R is $(1 \div 2)\%$. Parameter n_L characterizing LF LPF had been measured: Hz^{-1} $n_L \approx 10^{-12}\ Hz^{-1}$ at 1,3 kHz. These two values allow us to calculate the contribution of LPF to measurer resolution. Optical technique reducing RAM significantly has been developed.

A different path of LPM penetration into the precision chain we point out. There is significant temperature drift in the aluminum acoustic resonator length causing

frequency changes of interferometer $\Delta\nu_{RT}$ and laser $\Delta\nu_{LT}$. On the interferometer resonant transmittance curve operating point deviates from its maximum:

$\Delta\nu_{RL} \equiv \Delta\nu_{RT} - \Delta\nu_{LL} = \frac{\Delta\nu_{RT}}{K_{00}}$. Here K_{00} is a gain of feedback loop at zero frequency. Variable power component $P_{\sim}$ falling to a photodetector is $P_{\sim} = D_1\Delta\nu_{RT}\sin\Omega_{RF}t$. For ideal optical resonator me have $P_{_} = 2P_S$ and $D_1 = 8\frac{(P_cP_S)^{1/2}}{\Delta\nu_{R10}}$. Here

$\Delta\nu_{R10} = \frac{cF_1}{2L_1} = 25\ kHz$. The ratio $\frac{P_S}{P_c} = 0.25$ corresponds to approximately optimum modulation depth. Then $m = \frac{D_1\Delta\nu_{RL}}{P_{_}} = 8\frac{\Delta\nu_{R10}}{\Delta\nu_{RT}}$. For example values $\Delta\nu_R = 2.5 * 10^9\ Hz$ and $K_{00} = 10^7$ we find significant value $m = 8\%$.

Another way of LPM penetration is offered to attention. Vibratory interference with frequency range $10 \div 300\ Hz$ is available at the output of the discriminator channel. Its scope is commensurate with the scope of discriminatory curve ($40 - 50\ kHz$). It is the bearer of the LPF too. The fact of influence of significant Moscow industrial seismic background has been published; for this reason it had been proposed a modified version of a measurer with the second laser and heterodyning to extend the linearity of frequency demodulation region [PIRT'2013]. Discriminator channel has simple vibration isolation. The second PDH scheme with slow frequency retuning weakly suppresses this interference.

To estimate the effect we put $U_{CD} = D_2\Delta\nu_{im}\sin\Omega_I t$, where $\Delta\nu_m$ is amplitude of simulated interference deviation. This voltage carries LPM; selected narrowband noise is modulated by function $|\sin\Omega_I t|$. Envelope averaging gives the equivalent constant voltage $U_{CD-} = \frac{2}{\pi}D_2\Delta\nu_{im}$. We put $\Delta\nu_m = \frac{\Delta\nu_{INT}}{4}$, where $\Delta\nu_{R20} =.\frac{cF_2}{2L_2} = 28\ kHz$. Then $(S_v)^{1/2} = \frac{2}{\pi}\Delta\nu_{im}(n_L)^{1/2} = 4.5 * 10^{-3}\ Hz/(Hz)^{1/2}$. It means measurer resolution estimation $^{2}3 * 10^{-15}\ cm/(Hz)^{1/2}$ coinciding in level with above main source of noise.

On historical aspect of The Big Bang cosmological model appearance

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In the basis of The Big Bang cosmological model lies the expression of the metrics, corresponding to the equally curved space. It was first obtained by Einstein in 1917 by introducing the imaginary 4th spatial coordinate and its further exclusion,

expressing via the radius of space curvature. This mathematical formalism that allows to describe the curvature of the 3-dimensional space by the gravitational field, was introduced by Einstein when studying the stationary Universe. That is why when deducing the expression for the metrics, the differential of the excluded 4th spatial coordinate is expressed in Einstein's article through differentials of other three spatial coordinates but not through the space curvature radius differential, which in stationary Universe is equal to zero. At that the component of the metric tensor at time variable is a constant value and is accepted as equal to one.

In the non-stationary Universe, we cannot consider the differential of the space curvature radius to be equal to zero. However the standard cosmological model, describing the expanding Universe that appeared as a result of a catastrophic event (The Big Bang), is built on the same metric tensor that was obtained by Einstein in 1917 for the stationary Universe. The described situation appears to be paradoxical. In this work, we try to reconstruct the story of its appearance based on the existing literature.

The possibility to describe by Einstein's equations the non-stationary, changing in time world, was first shown in the works of the Russian physicist Alexander Friedmann. In 1922 Friedmann's work "On space curvature" was published, where he analyses the possibility to describe the world with curvature changing in time. In this work the value of the time component of the metric tensor was chosen by Friedmann for the purpose of comfort equal to 1 (with pointing out the possibility to re-define the time coordinate).

As a result of the retrospective journey we made into the works that lie in the basis of The Big Bang cosmological model, we can make a conclusion that there are two mistakes in the very foundation of this theoretical model made by Einstein and Friedmann in 1922-1925.

First of them – the mathematical mistake of Einstein at first reading of Friedmann's work, that, after the correction thanks to Friedmann's letter, allowed Einstein to fully rely on Friedmann's conclusions when exploring the cosmology problems further.

The second – the hygienic mistake of Friedmann who ate a pear infected with typhoid and died before the actual expansion of the Universe was discovered, so he could not apply practically the possibility (and the necessity) to re-define the variable of time.

It lead to the paradoxical situation – a cosmological model of the expanding Universe built on the metrics that corresponds to the zero value of the space curvature radius differential, i.e. stationary Universe.

Taking into account the non-zero value of "da" and building the Universe model on the basis of the metrics with $g_{00} = (1 - a'^2)$ leads to the cosmological model describing the Universe closed at any matter density, not requiring introduction of the additional non-observatory substances (cosmological constant or dark energy), infinite in time and expanding in accelerated manner at the current development stage. The slower expansion dynamics solves a range of problems of the standard

cosmological model and opens the possibility to describe the observed astronomic phenomena, not described by The Big Bang model.

Paradoxes of Quantum Theory from the viewpoint of the Special Relativity

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Albert Einstein valued quantum mechanics and the perfection of its mathematical theory. However, he considered physical interpretation of its statements unsatisfactory, because it contradicted the foundation of his physical worldview that can be expressed by one short phrase – the world is real. In this work we try to show that the value of the mentioned above Einstein's program thesis does not decrease because of the phenomenon that is called "quantum nonlocality" and the results of other experiments with photons.

What follows from the Special Relativity theory – the lifespan of the light beam (photons) in its own coordinates is always equal to zero, not depending on time and distance in our coordinates. From here it follows that the pair of photons, related ("entangled") at birth, must stay the same during all the time of their existence, because during the time equal to zero no any physical event can happen, including also due to the violation of their entanglement.

This approach allows to see from a new angle not only seemingly paradoxical results of Bell's inequality check but also other results of experiments with photons which seem today barely explicable and form a picture of "Quantum Challenge".

The creation of Dirac's quantum theory begins with introduction of a new notion – the superposition of states principle. Describing the experiments with photons polarizations Dirac describes it the following way: *"It is assumed that the photon polarized by angle to the optical axis, can be viewed as being in polarized condition partially to the parallel axis and partially – to the perpendicular axis. ... Because of this observation, we transfer the photon fully either into the state of parallel polarization or the one of perpendicular polarization. It must make a sudden hop from the partial being in both of these states to being fully in any of these states".*

But the approach based on derived from the Special Relativity theory conclusion about photon's own zero lifespan allows to describe this situation without hops of state at the moment of measuring. The photon does not remain in several possible states with sudden jump to one of them. It remains in one state, defined by the conditions on both ends of its path, because the interval of its own time between them is equal to zero. In the experiment described by Dirac, the photon both flies out and is being registered by the detector at the same moment of its own time – the moment when the conditions for its absorption by one of the atoms of one or another detector are created. And precisely in the polarization that corresponds to this detector.

The considered point of view, based on the findings of Special Relativity, can eliminate the use of the superposition principle and the notion of quantum leap.

We have shown that the results that look paradoxical from the point of view of the orthodox quantum mechanics, based on the principle of superposition of states and the notion of quantum leap at the moment of measurement, cease being paradoxical from the point of view of the relativity theory and the conception of action at a distance, correlating to it.

We conclude that, as the conception of action at a distance and the commonly accepted conception of the physical fields describe the same situation of the particles interaction at zero spacetime interval, it is appropriate to see them not as competing but as complementary to each other.

The attempt to complement two conceptions leads to the review of the interaction act in two equally valuable reference systems – the reference system of the particles, which at low speeds of their movement corresponds to the observer's coordinates and the reference system of interaction, which moving at light speed, where the moments of interaction of the particles-participants are always simultaneous.

It gives us possibility not to raise a question about which of these conceptions is valid, but focus on the interaction act itself, eliminates the contradiction and leads to two important consequences: it lets us to confirm the validity of two fundamental principles, "Mach's principle" and "principle of constancy of light speed", which lays in the basis of the Special Relativity.

On the question of everettical mechanism of formation of the Future from the Past

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The problem of the relationship between relativistic and quantum notions about actuality, as well as the construction of models of these interrelations, despite numerous attempts, remains relevant. This is especially true of the many-world Everett interpretations of quantum mechanics. Everettical aspects of the special and general theory of relativity were repeatedly discussed in the proceedings of the PIRT conference in different years. An important difficulty in promoting the program of quantum-relativistic unification is the inadequate elaboration of the conceptual apparatus of many-world and relativistic representations of actuality. Therefore, the improvement of this apparatus and the development and incorporation into it of new conceptual tools remains an urgent task.

In the paper, some aspects of the special theory of relativity are considered in connection with the emergence of a specific instrument of quantum mechanics - Johnbells Suarez's, described in Antoine Suarez (The Center for Quantum

Philosophy, Zurich, Switzerland) “The General Free Will Theorem”. This essence is one of the first quantum models that take into account the psychoid component of actuality. It makes it possible to conduct gedanken experiments demonstrating the need to take into account the factor of free will in describing world lines in the eventual Everett space. The method of achieving this goal is to describe gedanken experiments involving Johnbells Suarez's in two-zero-dimensional event space-time.

Two-dimensional space-time is supplemented by a zero-dimensional psychoid formation - Johnbell Suarez's. Unlike other hypotheses on the formation of relative states, this paper considers a model of the quasi-relativistic mechanism of transforming the world lines of the Past into the world lines of the Future, i.e. mechanism that takes into account the partition of the Everett space into “quasi-spatially-like” and “quasi-time-like” parts. The unit element of the geometric measurement of this space is the value of the characteristic size of the physical region of the relative state of the event (D). Since the event time is discrete, but obeys the causality principle, the characteristic frequency of the event change γ_{es} must be defined in it. This value is the characteristic parameter of the given relative state. It is obvious that the quantity $C_{es} = \gamma_{es\,max} D$ is an analogue of the speed of light in the SRT in the Everett space.

Based on this, the “light cones” for various D and γ_{es} are constructed and the consequences of such constructions are analyzed for the description of “world lines” (taking into account the presence at the “point of the Now” by Johnbell Suarez's). Both individual causal chains of the evolution of the relative states and the processes of transformation of the totality of the world lines of the Past into the world lines of the Future are analyzed.

As a result of the work, a hypothesis has been put forward that the Actuality - the relative state of the Observer and quantum reality - is formed from “everettical fouzia (sklejka)” of all possible “here-and-now” (in the presence of Johnbell Suarez's) in the real region (the vertex of the light cone of SRT).

The relativistic meaning of Zeno's aporia about the arrow is discussed, the impossibility of overcoming it in the continuum spaces of SRT is justified, and it is suggested that this aporia can be solved by taking into account the Everett concepts of Actuality.

During the analysis of the proposed model, it was also noted that the structure of the altervers of the Past and the Future contains both connected and disconnected areas (fibers).

The field of application of the results is the development of a conceptual apparatus of many-world interpretations of quantum mechanics and temporology.

For development of the made hypothesis further it is necessary to formalize mathematically the described mechanism for carrying out concrete calculations the everettical branchings of an altervers.

Anisotropy excess of red shift for supernovae type SN Ia

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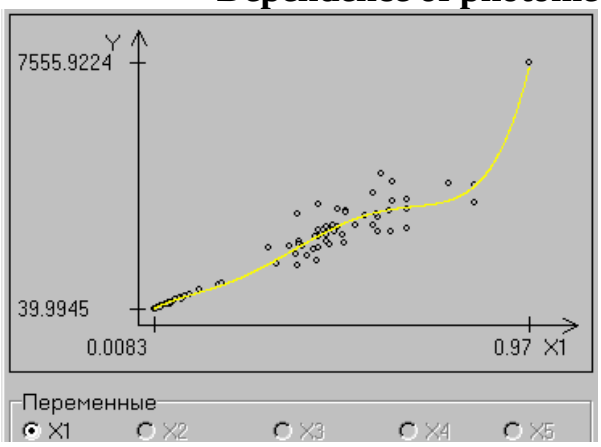
Necessary and paramount condition on importance of the correct decision of a measuring problem of structurally-parametrical identification of cosmological distances scale on the basis of red shift z on supernovae type SN Ia is increase of accuracy of definition of photometric distances D_L. In this direction essentially groups of researchers [1-2] before they managed to receive within the limits of model Friedman-Robertson-Walker the decision the conclusion about "acceleration of Universe expansion" became which consequence. The decision in the form of isotropic essentially nonlinear dependence D

$_L(z)$ has been received with the account non-uniformly precise definitions of photometric distances, peculiar galactic red shift and star sizes SN Ia in shine maximum. Thus alternative models were not considered, and problems of statistical methods application were not discussed.

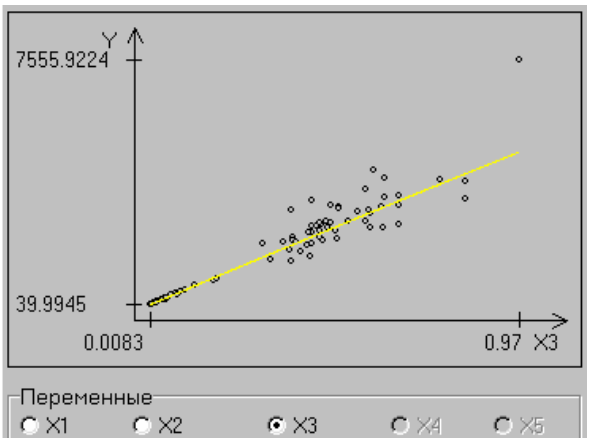
After B.P. Schmidt concerning these problems in the Nobel lecture recognized, that "it wasn't that they hadn't been solved by science, it was just that we were in new territory for us" though problems of this sort were constantly discussed, since the moment of opening of red shift by E. Hubble. And thereupon there was a question, whether statistical anisotropy of red shift SN Ia will affect effect of "acceleration of expansion of the Universe"?

Program use "MMK-stat M" [3] for sample of data about SN Ia [1,2] in a class of multidimensional sedate numbers has revealed an excess of statistical anisotropy on red shift and galactic windows of transparency. Thus by criterion of average module minimum for inadequacy error $\bar{\varepsilon}$ one-dimensional isotropic model $D_L(z)$ has appeared less plausible, than model with additional arguments (α,δ) in the form of angular co-ordinates of directions in space (fig.).

Dependence of photometric distance on red shift



D_L as function only z



D_L-projection as function α, δ and z

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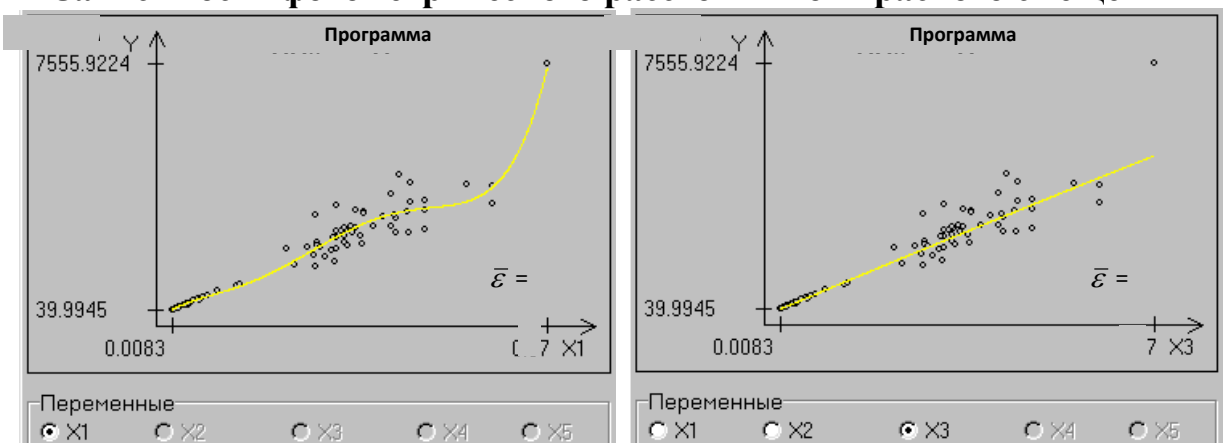
Необходимым и первостепенным по важности условием корректного решения измерительной задачи структурно-параметрической идентификации шкалы космологических расстояний на основе красного смещения z по сверхновым типа SN Ia является повышение точности определения фотометрических расстояний D_L. Именно в этом направлении существенно и продвинулись группы исследователей [1-2] прежде чем им удалось получить в рамках модели Фридмана–Робертсона–Уокера решение, следствием которого стал вывод об “ускорении расширения Вселенной”. Решение в виде изотропной существенно нелинейной зависимости $D_L(z)$ было получено с учетом неравноточности определений фотометрических расстояний, пекулярных галактических красных смещений и звездных величин SN Ia в максимуме блеска. При этом альтернативные модели не рассматривались, а проблемы применения статистических методов не обсуждались.

Позже Б.П. Шмидт в отношении этих проблем в нобелевской лекции признал, что «не то чтобы они были неизвестны науке, а просто мы были новичками в этой области», хотя проблемы этого рода постоянно обсуждались, начиная с момента открытия красного смещения Э. Хабблом. И в этой связи возник вопрос, не повлияет ли статистическая анизотропия красного смещения SN Ia на эффект “ускорения расширения Вселенной”?

Использование программы “ММК–стат М” [3] для выборки данных о SN Ia [1, 2] в классе многомерных степенных рядов выявило эксцесс статистической анизотропии по красному смещению и галактическим окнам прозрачности. При этом по критерию минимума среднего модуля погрешности неадекватности $\bar{\varepsilon}$ одномерная изотропная модель $D_L(z)$ оказалась менее правдоподобной, чем

модель с дополнительными аргументами (α, δ) в виде угловых координат направлений в пространстве (рис.).

Зависимость фотометрического расстояния от красного смещения



а) D_L как функция только z; б) D_L как функция α, δ и z в проекции $D_L(z)$.

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Р 50.2.004–2000 ГСИ. Определение характеристик математических моделей зависимостей между физическими величинами при решении измерительных задач. Основные положения.

Metric tensors for electromagnetic fields

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After Einstein successfully established the tensor equation

$$G_{\mu\nu} = R_{\mu\nu} - g_{\mu\nu}R = T_{\mu\nu},$$

he established the relativistic theory on gravitation. Since then there were numerous attempt by him and other scientists to develop the theory on electromagnetism and link it to gravitation. If we are able to link the Ricci tensor to the electromagnetic force directly, then we may apply the relativistic theory and develop the metric tensor for electromagnetism. Then we can apply the theory of relativity on electromagnetic forces other than gravitation. This paper shown that indeed from Poisson equation of electric charge density and Maxwell equation on electromagnetic wave, the Ricci tensor can be established and directly linked to electromagnetic force and the free standing waves. We are using the normal tensor

calculus following the conventional approach of relativity for the derivation of Ricci tensor in electromagnetic space. The scalar value of Ricci tensor can found to be $R = -4\pi\rho/\eta\varepsilon$, where ρ is the charge density, η and ε are some constants. From Maxwell equation, the Ricci tensor carry the expression

$$R^{\alpha}{}_{\beta\mu\nu} = -\nabla_{\nu} \times \nabla_{\mu} \times \varphi^{\alpha}{}_{\beta} / \eta = 0$$

and is a null tensor, where h is a proportional constant. Also following the standard method in general relativity by considering geodesic equation in time independent case and using the equivalance principle, we solve the metric tensor of electromagnetic fields in exponential form as

$$g_{\mu\nu} = \delta^{\mu}{}_{\nu} \exp\left(2\delta^{\mu}{}_{\nu}(\delta^{\mu}{}_{0} - \delta^{\mu}{}_{1})\varphi/c^{2}\right).$$

Our derivation has no conflict with the existing general theory of relativity and black hole thoery, but is a separate solution purely for electromagnetic sources. We found that the Ricci tensor for electromagnetic waves is null in value. So even a space is full of standing electromagnetic waves, the value of Ricci tensor can be null. Other than a trivial solution for a null tensor, we should have a non trivial solution in this case as the space is full of electromagnetic enery and is not a void space. The Scharzschild solution of gravitational metric tensor for a null Ricci tensor is a non trivial solution. Which means that for a space with only electromagnetic energy without mass, we can get a non trivial solution for gravitation. From here we conclude that gravitation is the secondary relativistic transformation of electromagnetic force. By deriving at the metric tensor, then we can apply it to photon and other elementary particles, especially for electron. Putting the metric tensors in the equivalance principle that equate the kinetic acceleration due to inertial and the potential acceleration due to action of field, we find that for negative potential, the kinetic acceleration is weaker than potential acceleration. That indicates that when an electron is attracted to a proton, the arch and spiral path described by the electron will has a smaller radius than expected, this is due to the inward centripetal acceleration cause by the potential between electron and proton will be greater than the outward centrifugal kinetic acceleration due to inertial and motion of the electron. The difference in kinetic acceleration due to inertia and potential acceleration due to action of field lead to many interesting predictions. We predicts that photon can be bend by strong magnetic field, electron will describe a smaller spiral path than the positron in pair production, that means the parting spiral path of electron is not the same as that of positron. By assuming photon is a train of quantized positive and negetive electromagnetic fields, we reason that the positive fields will experience a greater kinetic accleration than that of negatives fields in strong electric or magnetic field, this may split the photon into multiple twin waves and resulted in pair production. We further proposed that electron may be consisted of at least a pair of electromagnetic waves exchanging energy between them to maintain a stable packet of waves. By this model, we are able to derive the value of gravitation constant purely from electromagnetic constant using energy equations, this further support our view that gravitation is the secondary transformation of electromagnetic forces. What we have achieved in this paper is that we can apply the Ricci tensor to electromagnetic fields just as in general relativity which is applied to gravitational

field. By doing so we effectively unified the electromagnetic relativistic transformation with that of gravitation. This may serve as an important key for us to further study the structure of elementary particles and decipher the wave and corpuscular dual nature of particles. No new mathematical method is necessary but only the normal tensor calculus is used for the derivation of metric tensors in this paper. Last but not least, we have derived the gravitational constant as $G = G_0 + \Delta$. Where $G_0 = 2\sqrt{\frac{hc}{qc^2}}$ and Δ is the small factor contributed by the exchanging energy in particle.

Space and Time in the Theory of Relativity. The "Object Approach"

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According to the "object approach" in [1] the physical knowledge can be represented as a set of branches of physics, each of which has its own foundation in the form of a system of postulates that define the system of basic concepts. The central concepts are some ideal physical object A, its state of $S_A(n)$ and the physical process, described as object A transition from one state to another, where *time is the number of the state* (with the exception of equilibrium thermodynamics and statistical physics): $S_A(t_1) => S_A(t_2)$. Besides it is assumed that the *objects are in the space*. I.e. any branch of physics implies (as in Newton's mechanics) three associated with the motion entities (concepts): *object, space and time*. Theory of relativity occupies a special place in physics, because it does not introduce new physical objects, but enters into consideration the metric of space and time, and the last enters in all branches of physics, so they all have relativistic and nonrelativistic forms, with the exception of electrodynamics, which can be only relativistic. On the basis of these view, let's consider two questions.

1) What means "the object is in space", considering the discrediting of Newtonian absolute space idea as a container after the advent of STR and GTR? The answer in [1] is as follows. There is a space as "container" (like Newton said), but it is nonmetrizable space that allows to talk about ordering along selected lines, but not about distance. The situation is similar with the time: there is a "container" of events (like Newton said), but it is nonmetrizable time (Under notion of "event" in physics, we primarily mean finding an object in a particular state, although in TR the notion of "event" means finding an object in a specific location). The metrics of space and time depends on the position in space of other objects (bodies and fields) and on the speed and acceleration of the reference system. By virtue of these factors the metrics of space and time change in space and time. Einstein's equation determines these metrics and their variability.

2) What means 4-dimensional spatio-temporal diversity? Does it belongs to a physical model or it arises only in a mathematical representation used to Einstein's equations, which allows you to specify dependency metrics of time and space on the time and space?

We can put this question as in our “object approach” [1] to the structure of physical knowledge theory we have two levels: the level of physical model and the level of mathematical description, including mathematical images of object and its states, and equations linking states or metrics at different moments of time. If they are not divorced (which is typical for positivist look at physical knowledge structure, popular during the time of formation of TR, and remains popular today) such a question cannot even be put. The analysis of work in GTR shows that one: first takes position of bodies and fields in the 3-dimensional space at a given time, then constitute the 4-dimensional stress-energy tensor, which is inserted into Einstein's equation, then the result is transferred to the statement of the motion of bodies and fields in 3-dimensional space, which is the object of measurement (the same we have for the typical effects of the GTR like gravitational collapse), which will differ in different local reference systems.

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Пространство и время в ТО. Объектный взгляд

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Согласно представленному в [1] “объектному” подходу структуру физического знания можно представить как совокупность разделов физики, каждый из которых имеет свои основания в виде системы постулатов, задающих систему базовых понятий, в центре которых оказывается определенный идеальный физический объект A, его состояния $S_A(n)$ и физический процесс, представляемый как переход объекта А из одного состояния в другое, где *в качестве номера состояния* выступает (за исключением равновесных термодинамики и статистической физики) *время*: $S_A(t_1) => S_A(t_2)$. При этом предполагается, что *объект находится в пространстве*. Т.е. любой раздел физики предполагает, как и механика Ньютона, связанные с движением три сущности (понятия): *объект, пространство и время.* Теория относительности занимает в физике особое место, ибо она, не вводя новых физических объектов, вводит в рассмотрение *метрику пространства и времени*, а последние входят во все разделы физики,

поэтому все они имеют релятивистскую и нерелятивистскую формы, за исключением электродинамики, которая может быть только релятивистской. Исходя из данных представлений, рассмотрим два вопроса.

1) Что значит утверждение *“объект находится в пространстве”*, учитывая дискредитацию ньютоновской идеи абсолютного пространства как вместилища после появления СТО и ОТО? Ответ, содержащийся в [1], выглядят следующим образом. Существует пространство как “вместилище” (как у Ньютона), но это неметризованное пространство, которое позволяет говорить об упорядочении вдоль выбранной линии, но не о расстоянии. Аналогична ситуация со временем: существует время как “вместилище” событий (как у Ньютона), но это неметризованное время (под событием в физике мы, в первую очередь, имеем в виду нахождение объекта в определенном состоянии, хотя в СТО понятие “событие” закрепили за нахождением объекта в определенном месте). Метрики пространства и времени зависят от положения (заполнения) в пространстве других объектов (тел и полей) и от скорости и ускорения системы отсчета, вследствие чего меняются в пространстве и времени. Уравнение Эйнштейна определяет вид этих метрик и эту изменчивость.

2) Что означает 4-мерное пространственно-временное многообразие в ТО, надо ли его относить к физической модели или оно возникает лишь в математическом представлении, используемом для уравнения Эйнштейна, позволяющего указать зависимость метрик пространства и времени от пространства и времени? Подобный вопрос можно поставить, поскольку в развиваемом нами “объектном” подходе [1] структура физической теории имеет два уровня: уровень физической модели и уровень математического описания, включающего математические образы объекта и его состояний и уравнений, связывающих состояния или метрику в разные моменты времени. Если их не “расклеить”, что характерно для позитивистского взгляда на структуру физического знания, популярную во времена становления ТО, и остающуюся популярной сегодня, то подобного вопроса даже нельзя поставить. На то, что физическая модель по-прежнему существует в 3-мерноме пространстве и 1-мерном времени указывает анализ работы в ОТО: сначала берут 3-мерное положение тел и полей в данный момент времени, исходя из этого составляют 4-мерный тензор энергии-импульса, который вставляют в уравнение Эйнштейна, затем результат переводят в утверждение о движении тел и полей в 3-мерном пространстве, что и является объектом измерений (на это же указывает описание типичных эффектов ОТО типа гравитационного коллапса), результаты которых в разных локальных системах отсчета будут разными.

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Quasi-local energy and the application on the Kerr spacetime

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We brief summarized some works on the quasi-local energy (QLE), and the application on the Kerr spacetime in the Boyer-Lindquist coordinates. From the Hamiltonian point of view, a quasi-local quantity is defined by the boundary integration of the Hamiltonian boundary term on a spacelike 2-surface. It depends on the choice of reference and the displacement vector field. For the value of energy, the corresponding displacement vector field is timelike. By the method of 4D isometric matching, the choice of reference related to the 2-surface isometric embedding into a reference spacetime, and matching a timelike displacement vector field with respect to the timelike Killing vector field of the reference spacetime. Although the QLE is not unique (the 2-surface isometric embedding into a 4-spacetime and the matching of displacement vector field are not unique), its critical value for the Kerr-like spacetime is the Brown-York mass, which was showed by Tam and one of the author. For Kerr spacetime, the angular momentum a plays an important role. Smarr found that over the limit $a = \sqrt{3}m/2$, the outer horizon of Kerr black hole cannot be isometrically embedded into $\mathbb{R}^3$; Martinez has analyzed the Brown York mass for small a and here we discuss the Kerr case without taking the slow rotation approximation, which has the following results: (i) the critical QLE—the Brown York mass—is defined outside the certain region $r > r_k$, which is corresponding to the positive Gaussian curvature and particularly, the region $r < 2m$ is inside the ergosphere, where r_k is the real root of the cubic polynomial $r^3 + a^2 r - 6a^2 m$; (ii) when $a > \sqrt{3}m/2$, the integrand $k_0 - k$ is negative near the poles in the region for $r_k < r < \sqrt{3}a$ but (iii) for $r > \sqrt{3}a$, it is positive; (iv) the numerical results show that the critical QLE is positive and (v) monotonically decreasing with respect to the radius r; (vi) the critical QLE is increasing with respect to the irreducible mass M_{ir}, which implies that the larger critical QLE is corresponding to the larger black hole area ($A = 16\pi M_{\mathrm{ir}}^2$). That may be indicated by the second law of black hole dynamics.

Part of this report is based on our recent work [arXiv:1606.08177, accepted by Phys. Rev. D].

Experimental confirmation of the doubt about authenticity of the event GW150914

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The consequence of the principle of causality is a need to use minimum-phase (causal) filters for processing recording data in physics experiments.

Detection of pulse signals carried out on the basis of optimal detection theory and evaluation of the time of their entry obtained using registration data of LIGO 14.09.2015.

Soliton - like signals such as wavelet “Mexican hat” are found by a suboptimal (two-stage) causal filtering data registration, they have different polarity.

Their spectra are quite different and thus excluded an extraterrestrial source of their origin.

It is also found absence of two chirp signals, which announced February 11, 2016.

Suggested the reason of false separation chirp signals: application of whitening filters with zero phase shift.

Such filters are not causal (physically unrealizable), and leading to violation of the principle of causality and to false detection of LFM signals (chirp signals) and distortion their forms.

Doubts about the reliability of the detection of chirp signals, which announced February 11, 2016, are justified by the results the conducted analysis.

Gravitational experiments. Interpretation issues

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Theoretical and probabilistic analysis in the implementation of gravitational experiments was made. Evaluation of methodical error gravitational experiment is necessary.

Data on seismic, acoustic and electromagnetic conditions should also be considered to eliminate the influence of confounding factors on the results of registration of the gravitational signals.

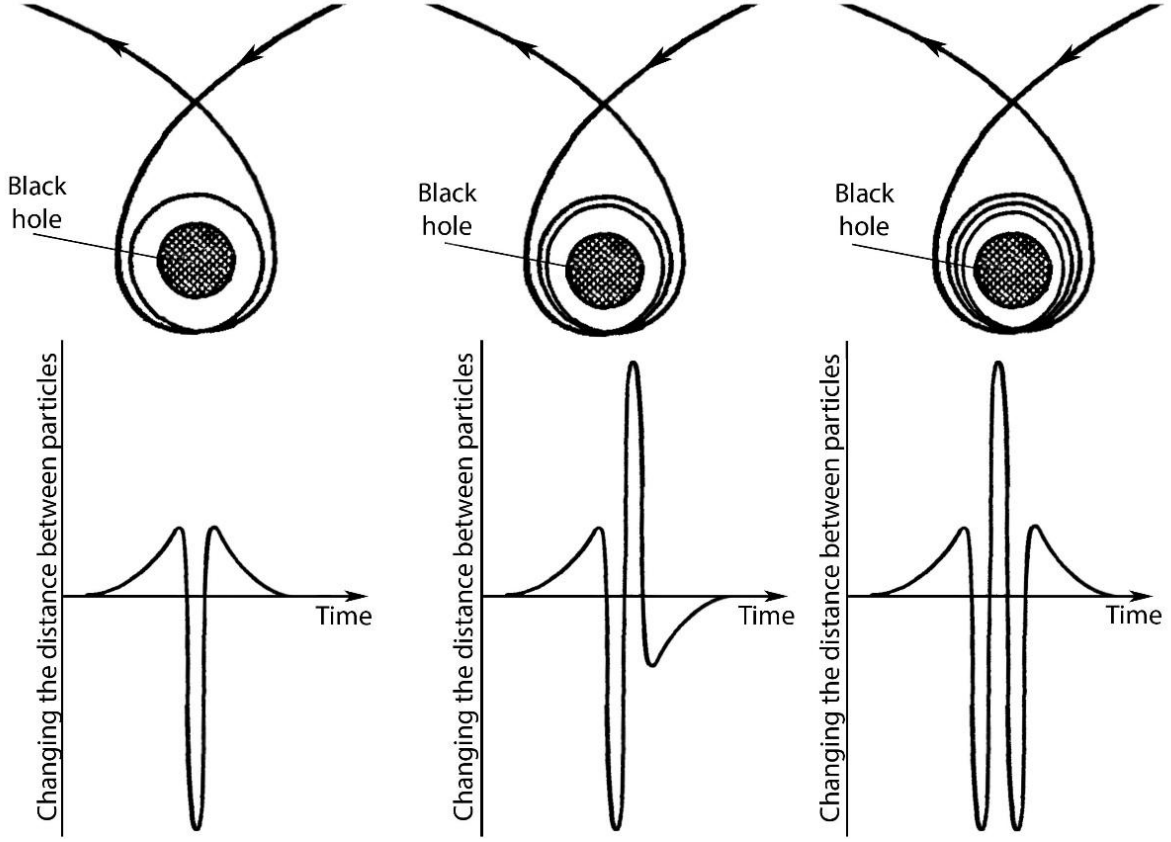
Movement of the body in a circular orbit around another body is a rare event and parabolic or hyperbolic trajectory without the merger are more likely.

The body makes several turns around the black hole and once again flies off in space.

Signals of GW-waves contains several half-periods is most likely.

The signal at one rotation coincides with inverted wavelet “Mexican hat”.

Signals of this type were detected earlier by the author.



Гравитационные эксперименты. Вопросы интерпретации.

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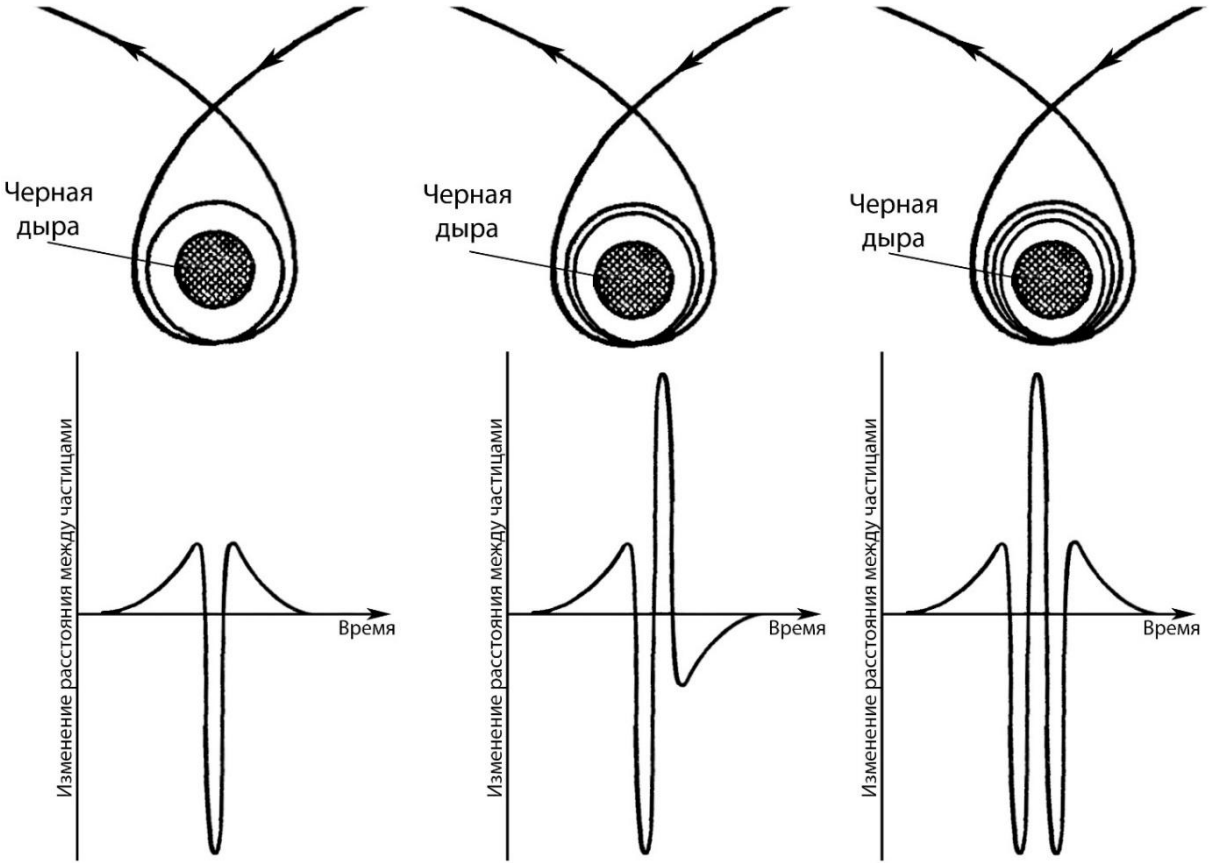
Проведен теоретико-вероятностный анализ проведения гравитационных экспериментов. Установлена необходимость оценки методической погрешности гравитационного эксперимента. Также должны учитываться данные о сейсмической, акустической и электромагнитной обстановках в районах размещения гравитационных телескопов для устранения влияния мешающих факторов на результаты регистрации полезных сигналов.

Движение тела по круговой орбите вокруг другого тела является редким событием и более вероятны параболические или гиперболические траектории без слияний. Тело делает несколько оборотов вокруг черной дыры и вновь улетает в пространство и соответственно наиболее вероятными сигналами ГВ-волн являются сигналы из нескольких полупериодов.

Сигнал при одном обороте совпадает с перевернутым вейвлетом “Мексиканская шляпа”. Именно такого типа сигналы были обнаружены автором ранее.



The variable Planck’s constant due to imaginary gravitational temperature

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In a talk in PIRT-2015 we described how the Tolman-Thorne temperature of a general relativistic spinning star can be used to define a variable Planck-type constant where the temperature becomes imaginary and how this variable has a negligible value except in some region near a stationary gravitating particle of given mass and spin. In the present talk we recover the Lamb Shift of the proton-electron system at thousands' place in MHz from the spread of this region. While this suggests that the variable Planck's constant could be used with linear Fourier analysis to approximate gravitational effects in coupling gravity with non-gravitational interactions quite effectively, we also consider Einstein-Yang-Mills coupled equations for possible solutions that could be stable because the variable coupling implied by a variable Planck's constant could stop the solutions from blowing up. While no new significant

result for these coupled equations has been found yet, we provide a progress report of an ongoing program in which eventually we would like to explain at least qualitatively every valid result in QM and QFT with the help of the variable Planck's constant suggested by GR (by which we mean here Einstein equations) and without using renormalization. We elaborate the first problem in more details. The remarkable coincidence in the earlier talk gave us a variable Planck's constant h_g of gravitational origin roughly at 0.2 Bohr radius for a gravitating particle having the mass and spin of a proton. In this talk we visit Welton's argument for the Lamb shift to see how far the Lamb shift can be explained with this h_g. The fluctuations of the quantized EM field used in Welton's argument would take place only in the region where h_g is meaningful. If we consider the Fourier transform of a real-valued function of a single variable having nonzero value1only on an interval of the positive axis, we see that the outer endpoint is proportional to the highest significant wave number and inner endpoint is proportional to the lowest significant wave number. The omitted frequencies produce the Gibbs' phenomenon. Thus the ratio of the cutoff frequencies used in Welton's argument $\frac{k_{max}}{k_{min}}$ becomes in our discussion $\frac{r_{max}}{r_{min}}$. If we take r_{min} to be the distance from the center of mass of the proton-electron system where the Tolman-Thorne temperature becomes imaginary and r_{max} to be the distance where $h_g \approx h$ (h_g decreasing as inverse square of r thereafter), we get values of our Lamb shift in the range 1019 to $1249\,MHz$. We do not expect to get the experimental value of $1057\,MHz$ following our crude qualitative arguments. The discussion on the variation of values based on Welton's argument namely 667 to $1394\,MHz$ (see for example the textbook of F. Schwabl) makes one appreciative of our values and hence of our suspicion that gravity is behind the significant part of the Lamb shift. The next task is to look closely wherever Planck's constant is used in the equations of quantum physics. Just naively replacing this Planck's constant by h_g will not give the full or a consistent story. In particular one would like to know how the Dirac equation and Einstein-Yang-Mills coupled equations get modified with h_g. A variable Planck's constant will make the coupling constant of the Einstein-Yang-Mills coupled system a varying function and the scale invariance of the system will be lost. We have done some initial calculation for the case of static Einstein-Yang-Mills equations. Spinning has not been added yet to keep the field equations manageable and so the justification behind using h_g is somewhat missing. However the indications are that we cannot have SU(2) solutions, and we cannot have spherically symmetric solutions unless possibly when the gauge group is more complicated. Otherwise the coupling is forced to become constant and we get the known unstable solutions. A sufficiently complicated gauge group gives more equations. Looking at the phase space of the known solutions we then expect that the varying coupling field may stop the blowing up of some otherwise singular solutions. The global solution is expected to be a stable solution because its constant coupling analog is not the unstable separator of the classes of YM-potentials going to $\pm\infty$. Some related issues and how our results can be improved will be discussed in the talk.

Commutative Fuzzy Geometry, Quantization and Space-time

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It's well known that the attempts to quantize gravity by use of standard quantization formalism result in principle difficulties [1]. It was proposed earlier that they can be resolved, if to reformulate quantum mechanics (QM) in purely geometric terms, so that both theories will be considered on the same mathematical ground. However, the particular formalisms investigated up to now, such as symplectic geometry, Hilbert manifolds, etc., didn't result in significant progress [2-3]. In our approach we exploit as the basis for such reformulation the standard geometry on real manifold equipped by specific weak topological structure; such theory called commutative fuzzy geometry (CFG) and applied now in wide range of scientific areas [4].

In any geometric theory its fundamental elements are points, in CFG its manifold beside the standard localized points includes also the subset of nonlocalized fuzzy points $\{b_i\}$ described in 1-dimensional case by normalized, positive distributions $w_i(x)$, which characterize their x coordinate uncertainty. We suppose that such evolving fuzzy point $b_m(t)$ describes massive particle m characterized by normalized density $w(x,t)$ [5]. It's shown that w evolution described by hydrodynamical flow continuity equation, for which w flow velocity $v(x,t)$ characterizes w motion as independent degree of freedom. In this case w, v pair corresponds to Dirac vector $\varphi(x,t)$ of complex Hilbert space, in particular, v x-derivative is proportional to particle quantum phase $a(x)$. It's proved that $\varphi(x,t)$ obeys to free Schroedinger equation, m interaction with external field can be accounted by phenomenological term $U(x,t)$ [6].

In the relativistic case the secondary quantization rules on fuzzy manifold were derived, they results in appearance of fuzzy occupation numbers for massive quantum fields, which correspond to Bogolubov state amplitudes. As the result, free massive particle evolution described by Dirac equation. It's shown that particle interactions with external fields on fuzzy manifold must be gauge invariant, thus, it imposes constraints on the possible form of fundamental interactions. It's shown that CFG the gravity quantization can be considered as the transition from Riemanian metrics to the space of fuzzy metrics, which describes the metric fluctuations at Planck scale.

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Motion in a central field with account of dark matter

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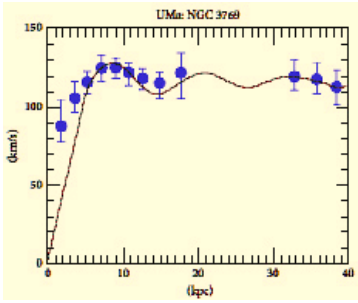
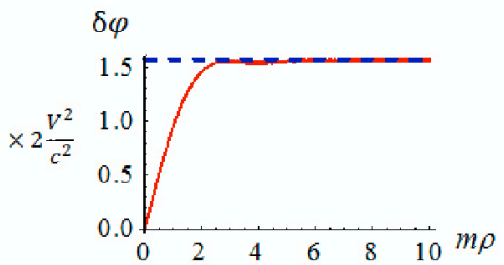
There are two most reliable manifestations of dark matter named galaxy rotation curves, and lensing. Despite the 90-year history the nature of dark matter is still a riddle. There are numerous publications with attempts to fit the observations. Research can be sorted into several directions, such as: inventing empirical models of dark matter profile, based on N-particle simulations, combining scalar, vector, and tensor fields for fitting the observations; considering "baryon feedback effect" to rule out "mysterious dark matter"; "improving" the Einstein's general relativity, and so on.



My approach is based on first principles. Describing dark matter by a longitudinal vector field allowed me to derive galaxy rotation curves analytically, and predict damping oscillations. I had presented it to PIRT-2015 two years ago (see Proceedings PIRT-2015 pp. 384-399). Fitting the rotation curve of a galaxy UMa NGC 3769 in Ursa Major cluster gives the estimate for observable value of plateau velocity V~130 km/sec, and period of damping oscillations $1/m$~10 kpc.

Meanwhile I have derived major lensing properties of dark matter on the periphery of a galaxy analytically, and would like to discuss the results on PIRT-2017.

Refraction of rays by dark matter on the periphery of galaxies turned out to be orders of magnitude stronger than by a star and even by a black hole. This allows us to explore distant objects in the Universe. By means of lensing, the accelerated expansion of the Universe was discovered. It means that, in addition to the mutual attraction, there is a mechanism of repulsion, existing long after the Big Bang. From my point of view, this discovery will lead to fundamental changes in our understanding the nature.



Derivation of bending of light by gravitation is the general procedure of solving the Hamilton-Jacobi equation. However, in the presence of dark matter metric functions $\nu(r)$ and $\lambda(r)$ differ from the Schwarzschild's ones. Linearization with respect to arbitrary $\lambda, \nu \ll 1$ is a nontrivial procedure. I couldn't find the correct

result $\delta\varphi(R) = \frac{1}{2}\int_{\rho}^{R}(\lambda + r\nu')(\rho^{-2} - r^{-2})^{-1/2}\, r^{-2}dr$ in the literature. Here ρ □is the impact factor (minimal distance of a ray from the center). $\delta\varphi$ is the bending angle. With the same metric functions as used for galaxy rotation curves we get analytic expression for bending angle $\delta\varphi$ as a function of dimensionless impact factor $m\rho$□□ (see fig 2). Bending angle is expressed in terms of the same observable values of plateau velocity *V*, and period of damping oscillations $1/m$.

Limiting cases: At $m\rho \ll 1$ the angle of refraction is a linear function of the impact parameter (r_{Sch} is the gravitational radius of a black hole): $\delta\varphi = \frac{2\pi}{3}\left(\frac{V}{c}\right)^2 m\rho, 1 \gg m\rho \gg mr_{Sch}\left(\frac{c}{V}\right)^2$. Typical value of $mr_{Sch}\left(\frac{c}{V}\right)^2$ is of the order 10□3. All rays within the interval $r_{Sch}\left(\frac{c}{V}\right)^2 \ll \rho \ll \frac{1}{m}$ cross the optical axis at the same point: $f = \frac{3}{2\pi}\left(\frac{c}{V}\right)^2 \frac{1}{m}$ For these rays a galaxy is a magnifying glass with the focal distance *f*. At $m\rho > 3$ (within the plateau region) dark matter is a medium with a constant refractive index $\delta\varphi = \pi\left(\frac{V}{c}\right)^2, m\rho \gg 1$.

Correlation of lensing and rotation curves looks useful for improving the accuracy of observations.

An Accelerating Dark Energy Model with Hybrid Scale Factor

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In this paper, the problem of anisotropic behaviour of the accelerating universe in Bianchi V space time has been studied in the frame work of General Relativity (GR). The matter field we have considered is of two non-interacting fluids i.e. the usual string fluid and dark energy (DE) fluid. The space-time can be represented as:

$$ds^2 = dt^2 - A^2dx^2 - e^{2\alpha x}\{B^2dy^2 + C^2dz^2\}, \quad (1)$$

where A, B and C are functions of cosmic time t only. To represent the pressure anisotropy, the skewness parameters are introduced along three different spatial directions. We have developed the field equations in Bianchi type V space time in presence of two fluids. Due to the highly non-linear nature of the field equations and in order to achieve a physically realistic solution, we need extra conditions. Based on the recent outcomes on the present universe, the appropriate choice for the scale factor are the de Sitter solution and the power law expansion. The behaviour of both power law and exponential law of the scale factor lead to a constant deceleration

parameter. However, the time dependence of the directional scale factor would be decided by specific choices of scale factors. So, we have considered the specific scale factor, the hybrid scale factor which at late time results into a constant deceleration parameter. The hybrid scale factor has two factors in the form, $R = e^{at}t^{b}$, where a and b are positive constants. In this combined form of the scale factor one form is on exponential expansion and the other is on power law expansion. The cosmic dynamics is dominated by the power law t^{b}in the early phase, whereas it is dominated by the exponential factor e^{at}at late phase. However, eventually, the hybrid scale factor pulls itself away towards later phase of evolution in a more dominant fashion which may mimic the accelerated expansion of universe.

In order to study the evolution of skewness parameters and the equation of state (EoS) parameters, we have developed the DE models in two fluid situations. The EoS parameter of DE evolves within the range predicted by the observations. In the present epoch, the DE dominates the universe. This may be attributed to the current accelerated expansion of the universe. In the constructed models, the matter energy density and DE density remains positive. Therefore, the energy conditions are satisfied, which in turn imply that the derived models are physically realistic. Moreover, it is shown that, there remain pressure anisotropies even at the late phase of cosmic evolution, though in the early phase pressure was assumed to be isotropic. Further the state finder pair is varying with time and decrease with the cosmic evolution in late time. Also, the EoS of parameter changed with cosmic time and which indicates that during evolution there exists a relationship between the mean pressure of the cosmic fluid and energy density. The total density parameter, which quantifies the density of matter in the universe is found to be in the observational range $[-1, 1]$. In most part of the evolution, the DE density dominates the matter density; however for a small range of the cosmic time, the matter density dominates the DE density. So, we can conclude through the behaviour of the density parameter, that our model also mimics the cosmic acceleration in the early phase and also in late phase

Superalgebraic structure of Lorentz transformations

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Modern relativistic theory of the second quantization of fermion and boson fields is based on the use of the mathematical apparatus of C^{*}-algebras and Lie superalgebras. In this case, for fermions, the Lorentz transformations are considered as Bogolyubov transformations of creation and annihilation operators. However, in this approach one can not obtain an explicit form of the Dirac gamma-matrices.

The mathematical apparatus of the superalgebraic representation of the algebra of the second quantization of spinors is developed in the article. It is based on the use

of density in the impulse space of Grassmann variables and their derivatives. It is shown that the Dirac matrices and the Lorentz transformation generators can be expressed in terms of such densities. A superalgebraic form of the Dirac equation and the vacuum state vector are constructed. It is shown that in the superalgebraic form of the complex Clifford algebra the generators corresponding to the Dirac gamma matrices are not equivalent. Clifford vector corresponding to diagonal matrixγ^0 annihilates the vacuum, and the remaining ones give nonzero values. This means that there is asymmetric direction corresponding to the time axis.

Супералгебраическая структура преобразований Лоренца

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Современная релятивистская теория вторичного квантования полей фермионов и бозонов основана на использовании математического аппарата C^*-алгебр и супералгебр Ли. При этом для фермионов преобразования Лоренца рассматриваются как преобразования Боголюбова операторов рождения и уничтожения. Однако в таком подходе не удается получить явный вид гамма-матриц Дирака.

В статье разработан математический аппарат супералгебраического представления алгебры вторичного квантования спиноров, основанный на использовании плотности в импульсном пространстве грассмановых переменных и производных по ним. Показано, что матрицы Дирака и генераторы преобразований Лоренца могут быть выражены через такие плотности. Построена супералгебраическая форма уравнения Дирака и вектора состояния вакуума. Показано, что в супералгебраической форме комплексной алгебры Клиффорда образующие, соответствующие гамма-матрицам Дирака, неравнозначны – клиффордов вектор, соответствующий диагональной матрице γ^0, аннулирует вакуум, а остальные при действии на вектор состояния вакуума дают ненулевые значения. Это означает наличие выделенного направления, соответствующего оси времени.

The structure of dark matter particles

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The author proposes a new model of the Universe, based on the physical analysis of the individual components of the tensor in the right-hand side of the

Einstein equation. It is shown that within the scope of an isotropic model, the spatial components T_{ik} have nothing in common with similar quantities for the energy-momentum tensor in the Special Relativity Theory. Nevertheless, despite additional constraints, the author has managed to make an unambiguous choice for a closed Universe from the class of isotropic models.

The new model (of Friedman type) differs from a “standard” one in the radius of curvature, which is a linear function of time: $a(t) = c\,t$. Under the new model the evolution of the universe is in constant development of its hierarchical structure. A consequence of the isotropy of the new model, in particular, is up-down-symmetry of most of its microstructure. The simplest up-down symmetric nucleon is the nucleus of deuterium. Consequently, the deuterium should be a large part of the invisible matter. But dark matter particles don't observe. Therefore, deuterium, a part of these particles is in a super dense state (~ 600 g/sm3). Electronic levels of normal molecular deuterium at this merge. The Fermi pressure of the compressed electronic components in dark matter particle is balanced by the specific ν-interaction between the deuterium nuclei. It ν-gravity due to exchange of virtual pairs of neutrinos-antineutrinos between neutrons within the nuclei of deuterium. Offers a relatively simple laboratory experiment to check the parameters ν-interaction.

Структура частиц темной материи

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В статье обсуждается новая космологическая модель, предложенная автором, на основе физического анализа отдельных компонент тензора, стоящего в правой части уравнений Эйнштейна. Показано, что в рамках изотропной модели пространственные компоненты T_{ik} не имеют ничего общего с аналогичными величинами для тензора энергии-импульса специальной теории относительности (СТО). Тем не менее, несмотря на дополнительные ограничения, автору удалось осуществить однозначный выбор закрытой космологической модели из класса изотропных. Новая космологическая модель Фридмана, отличается от “стандартной”. Радиус кривизны пространства линейно зависит от времени: $a(t)=ct$.

В рамках новой модели эволюция вселенной заключается в постоянном развитии ее иерархической структуры. Следствием изотропии новой модели, в частности, является up-down-симметрия большей части ее микроструктуры. Простейшим up-down-симметричным нуклоном является ядро дейтерия. Следовательно, именно из дейтерия должна состоять большая часть невидимой материи. Но частицы темной материи не наблюдаемы. Следовательно, дейтерий, входящий в состав этих частиц, находится в сверхплотном состоянии (~ 600 g/sm^3). Электронные уровни обычного молекулярного дейтерия при этом

сливаются. Ферми давление сжатой электронной компоненты в частицах темной материи уравновешивается специфическим ν-взаимодействием между ядрами дейтерия. Это ν-притяжение обусловлено обменом виртуальными парами нейтрино-антинейтрино между нейтронами, входящими в состав ядер дейтерия. Предлагается сравнительно простой лабораторный опыт для проверки параметров ν-взаимодействия.

Absolute velocity of earth from our stationary Michelson-Morley-Miller experiment at CIF, Bogota, Colombia

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Long ago in 1892, Lorentz wondered whether there is "*some point in the theory of Mr. Michelson's experiment which has as yet been overlooked?*" [1, p32]. At the turn of this century, present writer found an unaccounted weakness in all classical interferometric experiments: Michelson did not record the whole observed fringe-shift, but merely its fractional part; same experimental protocol was used by Michelson and Morley (MM), and also by Miller [2]. Thus, amplitude of the signal to calculate absolute velocity of earth was systematically underestimated.

Moreover, the implicit objective of the interferometric experiments was to determine the unknown direction and magnitude of solar motion. But, since 1881, Michelson and afterwards MM and Miller begged the question and assumed that the velocity of solar motion was known. This was finally noticed by Miller himself after the observations at Mount Wilson in March 27 and April 10, 1925, which "*proved that the presumptions as to the absolute motion of earth, upon which these calculations were based, were invalid*" [2, p222]. Miller added that it was "*necessary to determine the variations in the magnitude and in the direction of the ether drift effect throughout a period of twenty-four hours and at three or more epochs of the year*" [2, p223] (Miller's emphasis), as done by himself in April, August and September 1925, and February 1926. Unfortunately, in this final experiments Miller still registered the fractional part of the drift only.

Miller's continuous and long-series of observations were never repeated, until we did so in the 2002-2005 at CIF (Bogota, Colombia) with modern technology and implementing changes in design to account for additional issues in the pioneering experiments. In a preliminary phase in 2002, we determined feasibility of a stationary experiment with red and green lasers, and checked environmental stability; we also developed software to capture interference images at various rates of data sampling with a computer attached to a commercial video camera, and to convert analogue images into digital interference patterns. Data was collected day and night from January 2003 to February 2005, one image was recorded every minute for a total of 1,440 images in one daily rotation. In each month several runs were carried out, each

one of several days duration. Raw data was stochastically corrected for the environmental effect of pressure, temperature, and humidity. As usual in second-order experiments, two velocities of the sun relative to a preferred frame were obtained: (a) Northern celestial hemisphere: $V_s = 365\, km/s,\ R.A. = 5h - 24m,$ $Dec = 79^o$, and (b) Southern celestial hemisphere: $V_s = 500\, km/s,\ R.A. = 16h - 40m,\ Dec = -75^o$. These results are compatible with previous work supporting absolute motion.

Other connections to recent studies: (a) A well-controlled experiment at Stanford University measured frequency-changes in microwave cavities; they discarded observed periodic variation as "*mechanical disturbances*" [3]. But such disturbances are correlated with our values of earth velocity, thus hinting that dismissed variations may be related to absolute motion rather than local effects. (b) A high correlation with a recent experiment involving standing-waves in a Mach-Zender interferometer, showing solar but not sidereal effects [4].

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General relativity and gravity as part of a unified fluid and field theory

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Einstein's dream for a unified field theory of Nature is attained here via a classical fluid theory founded on space, time and spin —i.e. a $3 + 1 + 1$ theory, rather than Einstein's 4-spacetime. A Lorentz invariant quantum theory for a primordial fluid (PF) is described by the three-dimensional (3D) classical wave equation (CWE) also called homogeneous Klein-Gordon equation. For Schrödinger, the chief candidate to formulate quantum mechanics (QM) was the CWE, but he discarded it by superposition considerations, no longer relevant for non-linear Nature. We postulate a PF formed by sagions: energy-like, discrete, extended, spherical and Planck-size objects of radius R, carrying linear momentum P, spin S, moving in

absolute 3D-Euclidean space Σ with speed C along geodesics. Current empirical evidence, including CMB anisotropy, is also compatible with absolute space (see companion paper in this conference).

In the mid-1990s [1-2] present writer discovered novel nonharmonic and inherently quantized solutions for the CWE in spherical coordinates (not available when QM was born)

$$\frac{\partial^2\Psi}{\partial w^2} = \nabla^2\Psi,$$
$$\Psi = D(\theta,\varphi)M(r,w) = D(\theta,\varphi)\big(I(r) + Q(q)\big) = B(r,\theta,\varphi) + U(q,\theta,\varphi),$$
$$w \equiv Ct,\ \ q \equiv \frac{w}{r} \tag{1}$$

where C is the average local speed of sagions in the fluid. Directional component $D(\theta,\varphi)$ may be either spherical harmonics as in the standard solution of Schrödinger's equation, or a novel helicoidal solution propagating over a conical surface, whose vertex takes discrete values only [2]. Existence of helical solutions is well known, but inherent discreteness and quantization seems to be new. Rather than the usual time *t* and distance *r* separation of variables, in eq. (1) we used an entangled or mixed time-distance function $M(r,w)$, and obtained a time independent background field $B(r,\theta,\varphi)$ —which mimmicks action-at-a-distance and non-locality — and a unified time-dependent field $U(q,\theta,\varphi)$, applicable to all forces of Nature. Such separation amounts to reducing the 3D-CWE to a 1D-D'Alembertian travelling wave along a ray (*r*, *t*), arbitrarily oriented at (θ,φ) in isotropic space Σ. By analogy to Euler angles, variable q figuratively is a "cosine" angle of the "direction" θ_w of time. Unified field $U(q,\theta,\varphi)$ is isomorph under a large group of transformations between Σ and an inertial frame moving along ray (θ,φ) with speed V relative to Σ. This is called the D'Alembertian group, defined as:

$$s \to s' = f(B)(s - \beta w), w \to w' = f(B)(w - \beta r), where\ \beta \equiv \frac{V}{C}, \gamma = (1-\beta^2)^{\frac{1}{2}},$$
$$s = x, y, z, r$$
$$\cos\theta = \frac{s}{r}, (q, \cos\theta) \to (q', \cos\theta') = \left(\frac{w-\beta r}{r-\beta w}, \frac{s-\beta w}{r-\beta w}\right) \tag{2}$$
$$Neo\ Galilean\ (or, Galilei - Viogt): f(\beta) = 1,$$
$$Lorentzian: f(B) = \gamma, Poincare\ f(B) = \gamma l(\beta)$$

Standard Lorentz and Poincaré invariance obtains for $s = r$ where $\cos\theta = 1$ is invariant. There are three polynomial quingal functions $Q(q)$ (Quantized Universal Isomorphic under Neo-GAlilean and Lorentzian transformations). Quingal functions of the first-kind Q1 are quantized in near-field; four Q1-subgroups exhibit in far-field attractive/repulsive behaviour similar to inverse-square dependence with distance, with asymptotic zero/non-zero limits at infinite. Those features easily explain quantization and dark matter, main standing problems in gravity.

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Abstracts to the report GRT experiment: Supernova SN1987A

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General relativity (GRT), created by the genius of Einstein from 1907 to 1915 as a geometric theory of gravity, developing special theory of relativity (STR), has been 100 years does not rest and excites minds. Since then, it performed many experiments to confirm with great accuracy GRT. In this paper, we propose to draw attention to the possibility of direct experimental verification of the dependence of the velocity of light by the gravitational potential, what Einstein wrote in 1911 in his article "On the effect of gravity on light propagation" [1, V1, p.172]. We assume that nature itself has put this experiment in space in the presence of "dark matter", namely: February 23, 1987 in the Large Magellanic Cloud broke out amazing supernova SN1987A, from which the light came to Earth $2^h\ 47^m$ later neutrinos.

A. Einstein, outlining the general relativity theory (GRT), resulting in their articles the following experimental confirmation of GRT:

1. Explanation anomalous precession of Mercury peregeliya. In the article "Explanation peregeliya motion of Mercury in General Relativity" in 1915, Einstein, performing complex calculations came to the result: "The calculation gives for the planet Mercury to turn peregeliya $43''$ in a century" [1, V.1, s.446]

2. Bending of light rays in a gravitational field. "... The speed of light in a gravitational field is a function of the place ... the light rays propagating across the field of gravity should bend" [1, V.1, p.172]

3. The gravitational red shift, or time dilation in a gravitational field. "...According to our understanding, the spectral lines of sunlight should be displaced somewhat in comparison with the corresponding spectral lines of terrestrial sources of light in the red end of the spectrum..." [1, V.1, p.171]. "We have no reason to assume that the clock at the points with different gravitational potentials are to be regarded as equally reaching" [1, V.1, p.171]

4. to the dependence of the speed of light by the gravitational potential. "If we denote by c_0 speed of light in the origin, then the velocity of light c in a certain place with the gravitational potential is equal to Φ

$$c = c_0\left(1 + \frac{\Phi}{c^2}\right) \quad \text{[1, V.1, p.172]}$$

From the time of Einstein's done a lot of experiments that confirm with great accuracy GRT, but we suggest paying attention to Claim 4. from the list. We assume

that nature itself has set this experiment, namely: February 23, 1987 in a local group of galaxies in the Large Magellanic Cloud at a distance

$$R = 50\,kpk\ (163{,}0 * 10^3\ \text{light} - \text{years} = 5.1439 * 10^{12} s = T)$$

in the place the blue supergiant Sanduleak-1 B31 broke out amazing supernova SN1987A.

On the basis of numerous observations are given an explanation of this fact in terms of changing the speed of light neutrinos, and depending on the time-varying gravitational potential of the Universe.

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ОТО эксперимент: сверхновая SN1987A

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Общая теория относительности (ОТО), созданная гением А. Эйнштейна с 1907 по 1915 год как геометрическая теория гравитации, развивающая специальную теорию относительности (СТО), вот уже 100 лет не даёт покоя и будоражит умы. С тех пор выполнено много экспериментов, которые с большой точностью подтверждают ОТО.

В докладе мы предлагаем обратить внимание на возможность прямой экспериментальной проверки зависимости скорости света от гравитационного потенциала, о чём А. Эйнштейн писал в 1911 году в своей статье “О влиянии силы тяжести на распространение света” [1, т.1, с.172]. Мы предполагаем, что природа сама поставила этот эксперимент в космических условиях при наличии “тёмной материи”, а именно: 23 февраля 1987 года в Большом Магеллановом Облаке вспыхнула удивительная сверхновая звезда SN1987A, свет от которой прилетел на Землю на $2^h\ 47^m$ позже нейтрино. А.Эйнштейн, излагая общую теорию относительности (ОТО), приводит в своих статьях следующие экспериментальные подтверждения ОТО:

1.Объяснение аномальной прецессии перегелия Меркурия. В 1915 г. А. Эйнштейн пришёл к результату: *“Вычисление дает для планеты Меркурий поворот перегелия на 43″ в столетие”* [1, т.1, с.446]

2.Искривление лучей света в гравитационном поле. *“...скорость света в поле тяжести является функцией места..., лучи света, распространяющиеся поперёк поля тяжести, должны искривляться”* [1, т.1, с.172]

3.Гравитационное красное смещение, или замедление времени в гравитационном поле. *“...согласно нашим представлениям, спектральные линии солнечного света должны несколько сместиться по сравнению с соответствующими спектральными линиями земных источников света в сторону красного конца спектра...”* [1, т.1, с.171] *“У нас нет никаких оснований допускать, что часы находящиеся в точках с различными гравитационными потенциалами, должны рассматриваться как одинаково идущие”* [1,т.1,с.171]

4.Зависимость скорости света от гравитационного потенциала. *“Если мы обозначим через c_0 скорость света в начале координат, то скорость света с в некотором месте с гравитационным потенциалом Ф будет равна*

$$c = c_0\left(1 + \frac{\Phi}{c^2}\right) \quad [1, т.1, с.172].$$

“...я придерживаюсь мнения, что принцип постоянства скорости света можно сохранить до тех пор, пока мы ограничиваемся пространственно-временными областями с постоянным гравитационным потенциалом. По-моему, здесь лежит граница применимости не принципа относительности, а принципа постоянства скорости света и тем самым нашей теперешней теории относительности” (статья А.Эйнштейна 1912г. “Относительность и гравитация. Ответ на замечание М. Абрагама” [1, т.1, с.219].

В своей статье 1917г. “О специальной и общей теории относительности” А.Эйнштейн писал, что *“закон постоянства скорости света в пустоте, представляющий собой одну из основных предпосылок СТО, не может претендовать на неограниченную применимость…; ее результаты применимы лишь до тех пор, пока можно не учитывать влияние гравитационного поля на физические явления (например, световые)”* [1, с.568].

С времён А. Эйнштейна выполнено много экспериментов, которые с большой точностью подтверждают ОТО, но мы предлагаем обратить внимание на п.4. из этого перечня, и предполагаем, что природа сама поставила этот эксперимент, а именно: 23 февраля 1987 года в местной группе галактик в Большом Магеллановом Облаке на расстоянии $R = 50\,kpk$ ($163{,}0 * 10^3$ св. лет $= 5.1439 * 10^{12} s = T$) на месте голубого сверхгиганта Sanduleak-1 B31 вспыхнула удивительная сверхновая звезда SN1987A. В докладе на основе многочисленных наблюдений даётся объяснение этого факта с точки зрения изменения скорости света и нейтрино в зависимости от изменяющегося во времени и места гравитационного потенциала Вселенной.

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Geometrical interpretation of time

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The time is considered in Mechanics as one of the four coordinates (t, x_1, x_2, x_3) in the so called "space of events", where scalar t is the "moment of time" when the event takes place and x_1, x_2, x_3 are coordinates of the "place of event". Hard sticks are standards for measuring of coordinates of "places of events" and periodical movements (clocks) are standards for measuring of "moments of time". Definition of standards means that the space of events can be investigated by physical methods, and it was established that three coordinate x_1, x_2, x_3 describe three dimensional Euclidean space. This space looks, intuitively, as understandable one because its standards have dimensionality of length. On the other hand, time does not look understandable on the basis of notions from everyday life. Here we show that time can be considered as some distance with dimensionality of length in the special many-dimensional space that is adjacent to our Euclidean space. It means that notions "space" and "time" can be reduced to attributes of one notion – "many dimensional space with definite geometry." The Galileo's inertia law and existence of the limiting velocity of motion appear to be consequences of the geometrical structure of the suggested model of the space-time.

The formal geometrical interpretation of time is known where time is considered as an imaginary fourth coordinate with the dimensionality of length in the four dimensional pseudo Euclidean space (Minkowski space). But representation of time by means of imaginary numbers does not give the opportunity to understand reasons of the deep difference between notions "space" and "time". Instead of fictitious Minkowski space, the geometrical model of the space of events is considered where all coordinates are real numbers

This work is a continuation of author's investigations of possibility to explain physical phenomena by geometrical properties of the space-time. In these investigations the idea was used about increasing dimensionality of our Euclidean space from three to four – the idea firstly used by Kaluza and then by Bergmann and Einstein in their attempts to geometrize electromagnetic field. The idea about additional dimensionalities is the main idea of this work, and this idea is based on the hypothesis that the space of events is a special case of the topological product of the usual Euclidean space and some space with the topology of closed manifold.

The Basic Properties of the Field of Time

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In papers [1-2] it is shown, that the time can be consider as the scalar potential, closely related with the wave equation and its extensions, such as Poisson, Helmholtz, Klein-Gordon equations. In the corresponding model the pace of time, in general case, has not constant value, but substantially depends on external conditions. If the field of time is scalar field, the field of pace of time is space-time 4-vector field. It is proposed to call the second one as the hyperbolic field. It has some interesting properties, which is not considered earlier. First of all, it can be noted, that there are two kinds of elementary singularities of the hyperbolic field looks like source (outflow) and vortex. These elementary singularities are not point patterns, but, if it can be expressed, are “smeared” alone light cones, which are pseudo-Euclidean spheres of zero radii (interval) from the point of view of 4-geometry. It means that interaction of sources and vortexes of the hyperbolic field is not local in principals. Flat pictures of interactions between two or more 4-dimension hyperbolic sources and vortexes will be presented in the report. These pictures are space-time generalizations of flat pictures of interactions of usual 3-dimension sources.

The simplest hyperbolic fields can be potential and solenoid; it is nature generalization of respective concepts of usual space vector fields. Oddly enough hyperbolic field is not theme of regular and comprehensive studies by physicists, although it very close associated with one of the most important physic concepts: time.

One of the few persons, who tried to think about time in accordance with its field nature, was the soviet astrophysicist Nicolay Alexandrovich Kozyrev and his followers. But they apparently failed to move in direction of maximum full description specifically of hyperbolic field and its connection with time both mathematically and experimentally yet. The reason of this fail in a way is conviction of modern physicists, that metrics of real 4dimencion space time is necessary quadratic, while for comprehensive understanding of place and role of hyperbolic vortexes it is necessary to assume possibility of Finsler extensions of geometry in general, and the relativity theory particularly.

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Exact solutions of Friedmann equation for supernovae data

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Type Ia supernovae are standard candles which one could use to test cosmological models. Recent observations of the supernovae have led cosmologists to conclusion of the Universe filled with dust and mysterious dark energy in frame of standard cosmology [1]. The conformal cosmological model [2] allows us to describe the supernova data without Lambda term. Fitting of the Hubble diagram with use of conformal cosmological model with parameters $\Omega_{rigid} = 0{,}755$, $\Omega_M = 0{,}245$ yields the same qualitative approximation as the standard cosmological model with $\Omega_\Lambda = 0{,}72$, $\Omega_M = 0{,}28$ [3]. Here Ω_M is a parameter of barionic density of matter, Ω_Λ is a parameter that corresponds to a Λ term, a parameter Ω_{rigid} corresponds to rigid state matter. A relation: luminosity distance – redshift is presented in analytical form. Formulae belong to a class of Weierstrass meromorphic functions [4]. In standard cosmology the Hubble parameter $H(t)$, a deceleration parameter $q(t)$, and a jerk parameter $j(t)$ are used [1]:

$$H(t) = +\left(\frac{\dot{a}}{a}\right) = H_0\sqrt{\frac{\Omega_M}{a^3} + \Omega_\Lambda},$$

$$q(t) \equiv -\left(\frac{\ddot{a}}{a}\right)\left(\frac{\dot{a}}{a}\right)^{-2} = \frac{\frac{1}{2}\Omega_M - \Omega_\Lambda a^3}{\Omega_M + \Omega_\Lambda a^3},$$

$$\boldsymbol{j(t) = +\left(\frac{\dddot{a}}{a}\right)\left(\frac{\dot{a}}{a}\right)^{-3} = 1}$$

Here H_0 is the Hubble constant, a is a scale factor; dots denote derivatives with respect to coordinate time. The q - parameter changes its sign during the Universe's evolution at an inflection point of curve $a(t)$, the j-parameter is a constant, which leads to an enigma: what is the reason for changing expansion from deceleration to acceleration regime? We believe that we should be careful choosing the coordinate time in studying such distant objects. In capacity of time, we take the time of a photon - the conformal time. In conformal cosmology $H(\eta), q(\eta), j(\eta)$, stay positive during all evolution:

$$H(\eta) \equiv +\left(\frac{a'}{a}\right) = \frac{H_0}{a^2}\sqrt{\Omega_{rigid} + \Omega_M a^3} > 0, \qquad \ldots$$

$$q(\eta) \equiv +\left(\frac{a''}{a}\right)\left(\frac{a'}{a}\right)^{-2} = \left(\frac{\Omega_{rigid} - \left(\frac{1}{2}\Omega_M\right)a^3}{\Omega_{rigid} + \Omega_M a^3}\right) > 0,$$

$$j(\eta) \equiv +\left(\frac{a'''}{a}\right)\left(\frac{a'}{a}\right)^{-3} = \frac{3\Omega_{rigid}}{\Omega_{rigid} + \Omega_M a^3} > 0$$

Here $\boldsymbol{H_0}$ is a conformal Hubble constant; the dashes denote derivatives with respect to conformal time. As we see, the Universe has not been undergone a jerk that is a subject of discussion in [1].

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Точные решения уравнения Фридмана для данных по сверхновым

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Сверхновые типа Ia служат стандартными свечами для проверки космологических моделей. Последние наблюдения за сверхновыми привели космологов к заключению, что Вселенная, с точки зрения стандартной космологии, заполнена в основном пылью и загадочной тёмной энергией [1]. Конформная космологическая модель [2] позволяет объяснить данные по сверхновым без Λ - члена. Фитирование диаграммы Хаббла с помощью конформной космологической модели с параметрами $\Omega_{\mathrm{rigid}} = 0{,}755$, $\Omega_{\mathrm{M}} = 0{,}245$ даёт такую же качественную аппроксимацию, какую даёт стандартная космологическая модель с параметрами $\Omega_\Lambda = 0{,}72$, $\Omega_M = 0{,}28$ [3]. Здесь Ω_M - параметр барионной плотности материи, Ω_Λ параметр, характеризующий вклад Λ - члена, параметр Ω_{rigid} отвечает сверхжёсткому состоянию материи. Соотношения: фотометрическое расстояние – красное смещение находятся в аналитическом виде. Формулы выражаются в мероморфных функциях Вейерштрасса [4]. В стандартной космологической модели для описания диаграммы Хаббла используются три характеристики: параметры Хаббла H(t), замедления q(t) и толчка j(t) [1]:

$$H(t) = +\left(\frac{\dot{a}}{a}\right) = H_0\sqrt{\frac{\Omega_M}{a^3} + \Omega_\Lambda},$$

$$q(t) \equiv -\left(\frac{\ddot{a}}{a}\right)\left(\frac{\dot{a}}{a}\right)^{-2} = \frac{\frac{1}{2}\Omega_M - \Omega_\Lambda a^3}{\Omega_M + \Omega_\Lambda a^3},$$

$$\boldsymbol{j(t) = +\left(\frac{\ddot{a}}{a}\right)\left(\frac{\dot{a}}{a}\right)^{-3} = 1}$$

Здесь H_0 - постоянная Хаббла, a - масштабный фактор; точками обозначены производные по координатному времени. Параметр q замедления меняет свой знак в течение эволюции в точке перегиба кривой a(t), что приводит к загадке: какова причина смены режима замедления на ускоренное расширение? Мы считаем, что следует проявить осторожность, делая свой выбор на координатном времени при изучении столь удалённых от нас объектов. В качестве времени мы выбираем время фотона – конформное время. В конформной космологии параметры $H(\eta), q(\eta), j(\eta)$, остаются положительными в течение эволюции:

$$H(\eta) \equiv +\left(\frac{a'}{a}\right) = \frac{H_0}{a^2}\sqrt{\Omega_{rigid} + \Omega_M a^3} > 0, \quad \ldots$$

$$q(\eta) \equiv +\left(\frac{a''}{a}\right)\left(\frac{a'}{a}\right)^{-2} = \left(\frac{\Omega_{rigid} - \left(\frac{1}{2}\Omega_M\right)a^3}{\Omega_{rigid} + \Omega_M a^3}\right) > 0,$$

$$j(\eta) \equiv +\left(\frac{a'''}{a}\right)\left(\frac{a'}{a}\right)^{-3} = \frac{3\Omega_{rigid}}{\Omega_{rigid} + \Omega_M a^3} > 0$$

Здесь $\boldsymbol{H_0}$- конформная постоянная Хаббла, а штрихами обозначены производные по конформному времени. Как видим из формул, Вселенная не испытывает загадочный толчок – предмет обсуждения в [1].

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Bianchi Type Cosmological Models with Perfect Fluid and Dark Energy

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In the present paper we have studied the investigations of LRS Bianchi type-I space-time filled with two minimally interacting fields, perfect fluid and dark energy components with separate conservation of their energy momentum tensors. In order

to obtain a deterministic solution of highly nonlinear Einstein's field equations, the EoS parameter of the perfect fluid is assumed to be constant. In addition to this we have used a special law of variation of Hubble's parameter proposed by Berman (1983) that yields a constant deceleration parameter. For two different values of the constant deceleration parameters we are getting two different dark energy cosmological models of the universe which are power law model and exponential model. Some physical features that both the models exhibits are discussed.

Spherically symmetric collapse to a point-like state

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Perhaps one of the greatest discoveries of all time has been stated. It is a direct detection by laser interferometer gravitational-wave observatories (LIGO and VIRGO) of the gravitational waves produced in the events of coalescence of binary black holes. To be convinced in the prediction of the LIGO's and VIRGO's discovery a systematic theoretical study was carried out and is carried out. In the framework of such studies, researchers derive equations of motion of compact components, e.g., two black holes. Such a description usually is modeled by point-like particles presented by the Dirac's δ-function and, next, post-Newtonian approximations are used. However, by this way many problems of construction and interpretation appear.

We present the other (original) way of exact (without approximations) presentation of a black hole (we consider only the Schwarzschild solution) in the form of a point-like mass in general relativity (GR). Moreover, we outline a continuous collapse to such a point. To realize these goals we restrict ourselves by the following requirements:

1) The true singularity has to be described by the world line $r = 0$ with the use of the Dirac's $\delta(r)$ – function.

2) The Schwarzschild solution has to be presented in the asymptotically flat form with appropriate fall-off of potentials at spatial infinity consistent with the Newtonian law.

3) Such a model has to be consistent with a spherically symmetric collapse. Therefore, we require that test particles fall from infinity to achieve the true singularity continuously in a spacetime diagram.

To satisfy the requirement 1) one cannot use the standard geometrical presentation of GR, where the true singularity is not a point - it is a spacelike singular hypersurface. Moreover, this fact is invariant with respect to exchanging coordinates. Attempts to apply the geometrical description lead to curious results only, when $\delta(r)$ – function is defined for the timelike coordinate r. Another reformulation of GR, in the framework of so-called field-theoretical approach, allows us to solve the problem of the $\delta(r)$ – function. The field-theoretical description can be constructed with the

help of a simple decomposition of the variables of the geometrical formulation of GR into a sum of background and perturbed (dynamical) variables. All the dynamical fields, including the gravitational field, are considered as propagating in a background (fixed, auxiliary) spacetime (curved or flat). By the construction, it is evident that the geometrical and the field-theoretical formulations are equivalent, therefore any solutions to GR can be treated in the framework of each of the approaches. Main details of field-theoretical formulation of GR one can find, for example, in [A.N. Petrov, "Nonlinear Perturbations and Conservation Laws on Curved Backgrounds in GR and Other Metric Theories", in the book: *Classical and Quantum Gravity Research* (Nova Science Publishers, N.Y., 2008), p.p. 79 – 160; arXiv:0705.0019 [gr-qc]]. The requirements 2) and 3) are consistent both with geometrical and field-theoretical descriptions of GR.

Сферически симметричный коллапс до точечно-подобного состояния

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Одно из самых величайших открытий всех времен - это прямое детектирование лазерными интерференционными гравитационно-волновыми антеннами (LIGO и VIRGO) гравитационных волн сгенерированными двумя столкнувшимися черными дырами. Чтобы правильно описать эти открытия систематические теоретические исследования проводились и проводятся. Для этого исследователи выписывают уравнения движения компактных компонент представляющих две черные дыры. Такое описание, как правило, моделируется точечно подобными частицами представленными дираковскими функциями, далее используются пост-ньютоновские аппроксимации. Однако, на этом пути встречаются серьезные проблемы итерационных построений и интерпретации.

Мы представляем новый способ точного (без приближений) представления черной дыры (мы рассматриваем только решение Шварцшильда) в виде точечной массы в общей теории относительности (ОТО). Кроме того, мы описываем непрерывный коллапс до точечного состояния. Для реализации этих целей мы выдвигаем требования:

1) Истинная сингулярность должна описываться мировой линией $r = 0$ с использованием дираковской $\delta(r)$ – функции.

2) Решение Шварцшильда должно быть представлено в асимптотически плоской форме с подходящим падением потенциалов на пространственной бесконечности совместным с законом Ньютона.

3) Чтобы описать непрерывный сферически симметричный коллапс мы требуем, чтобы пробные частицы, падающие от бесконечности, достигали

4) истинной сингулярности непрерывным образом на пространственно-временной диаграмме.

Чтобы удовлетворить 1) невозможно использовать стандартное геометрическое представление ОТО, где истинная сингулярность не является точкой - это пространственно-подобная гиперповерхность. Кроме того, этот факт инвариантен для координатных преобразований. Попытки использовать геометрической представление приводит к курьезным результатам, когда $\delta(r)$ – функция определена для времени-подобной координаты r. Другая формулировка ОТО в рамках так называемого теоретико-полевого подхода позволяет решить проблему $\delta(r)$ – функции. Такое описание достигается с помощью разбиения геометрических переменных на сумму фоновых и возмущенных переменных. Возмущения рассматриваются как динамические поля, включая гравитационное, в фоновом пространстве-времени (искривленном или плоском). В силу построения геометрическое и теоретико-полевое описания эквивалентны. Поэтому одно и то же решение ОТО может трактоваться в рамках каждого из подходов. Свойства теоретико-полевого подхода могут быть найдены в обзоре [A.N. Petrov, “Nonlinear Perturbations and Conservation Laws on Curved Backgrounds in GR and Other Metric Theories”, in the book: *Classical and Quantum Gravity Research* (Nova Science Publishers, N.Y., 2008), p.p. 79 – 160; arXiv:0705.0019 [gr-qc]]. Наконец, требования 2) и 3) вполне совместны в рамках обоих подходов.

Connection the functionals of field-theory equations with the state functionals of equations of mathematical physics

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It is shown that from the equations of mathematical physics describing material systems (material media) such as the thermodynamic, gas-dynamic and cosmic systems as well as the systems of charged particles and others it follows the evolutionary relation for state functionals, such as the action functional, entropy, Pointing's vector, Einstein's tensor, wave function, and others.

It is well known that the field-theory equations are equations for such functionals. This fact discloses a connection between the field-theory equations and the equations of mathematical physics and enables one to understand the basic principles of the field theory and the properties of physical fields.

The present investigation bases on the properties of conservation laws. It is known that the equations of mathematical physics for material media consist of the equations of conservation laws for energy, linear momentum, angular momentum, and mass.

The relations for state functionals that characterize the material system state is obtained when investigating the consistency of the conservation law equations. Under such investigation the properties of physical quantities of material media were taken into account. Since the physical quantities (like temperature, energy, pressure or density) relates to a single material medium, a connection between them should exist. Such a connection is described by state functionals. The functionals pointed above are such state functionals.

These results were obtained by using skew-symmetric forms. In addition to exterior forms, the skew-symmetric forms, which are obtained from differential equations and, in distinction to exterior forms, are evolutionary ones and are defined on nonintegrable manifolds, were used.

Testing of Accelerating Universe in Anisotrpic Bianchi Type Space-Time

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Motivated by the increasing evidence for the need of a geometry that resembles Bianchi morphology to explain the observed anisotropy in the WMAP data, we have discussed some features of the Bianchi type universes in the presence of a fluid that wields an anisotropic equation of state (EoS) parameter in general relativity. Such models are of great interest in cosmology in favour of constructing more realistic models than FLRW models with maximally symmetric spatial geometry. Additionally, the interest in such models was pro-moted in recent years due to the debate that going on the analysis and the interpretation of the WMAP (Komatsu et al. 2009, 2011; Sperget et al. 2007) data, whether they need a Bianchi type morphology to be explained successfully (de Oliveira-Costa et al. 2004; Bennet et al. 2003, 2011; Hoftuft et al. 2009). The ILC-WMAP data maps show seven axes well aligned with one another and the direction Virgo. For this reason Bianchi models are important in the study of anisotropies.

In the present study of Bianchi type-I, II, III, V and VI0 space-times, we observe that the EoS for dark energy ω is found to be time-dependent and its existing range for derived models is in good agreement with the recent observations of SNe Ia data (Knop et al. in Astrophys. J. 598:102, 2003), SNe Ia data with CMBR anisotropy and galaxy clustering statistics (Tegmark et al. in Astrophys. J. 606: 702, 2004) and latest combination of cosmological datasets coming from CMB anisotropies, luminosity distances of high redshift type Ia supernovae and galaxy clustering (Hinshaw et al. in Astrophys. J. Suppl. 180:225, 2009, Komatsu et al. in Astrophys. J. Suppl. 180:330, 2009). It has been suggested that the dark energy that explains the observed accelerating expansion of the universe may arise due to the contribution to the vacuum energy of the EoS in a time dependent background. The cosmological

constant Lambda is found to be a positive decreasing function of time and it approaches to a small positive value at late time (i.e. the present epoch) which is corroborated by results from recent type Ia supernovae observations.

Anisotropy in viscous fluid dark energy cosmological model

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In the present work, we have constructed an anisotropic dark energy universe in the framework of General Relativity at the back drop of spatially homogenous and anisotropic Bianchi V metric, i.e., $ds^2 = dt^2 - \sum_{i=1}^{3} e^{2a_i x} {b_i}^2 {dx_i}^2$,

Where, the directional scale factors bi, $i = 1,2,3$ are considered to be different along three orthogonal directions choosing $a1 = 0, a2 = a3 = a$.

To set the corresponding governing equations of the model via Einstein's field equations, we choose the matter field to be composed of two non-interactive fluids namely, bulk viscous fluid and dark energy fluid, having their corresponding energy momentum tensors (T_{ij}),

$$T_{ij}^{vis} = (\rho + \bar{p})u_i u_j - \bar{p} g_{ij} \text{ and}$$

$$T_{ij}^{de} = diag\ [1, -(\omega^{de} + \delta), -(\omega^{de} + \gamma), -(\omega^{de} + n)]\rho^{de}$$

Where, ρ and ρ^{de} are densities of corresponding matter source, $\bar{p}$ is effective pressure of barotropic cosmic fluid, ω^{de} is the directional equation of state parameter of dark energy fluid, δ, γ, n are deviations from ω^{de} in orthogonal directions, making the cosmic fluid anisotropy.

The anisotropic behavior of the model is simulated through the consideration of different scale factors and Hubble expansion rates along different spatial directions.

Since universe have under gone a transition from early deceleration to late time acceleration at certain point of time, such situation can be simulated through a time varying deceleration parameter which can be generated from a scale factor having a hybrid form containing factors of exponential behavior and power law behavior of the form $R = e^{at} t^b$, where a and b are positive constants. While the power law behavior dominates the cosmic dynamics in early phase of cosmic evolution, the exponential factor dominates at late phase, providing a realistic cosmological model.

We followed the general formalism developed for dark energy models with pressure anisotropy to get the evolution of skew ness parameters, equation of state parameters and density parameters. In the context of the discussed model, we have constrained parameters of the hybrid scale factors from some observational as well as physical bounds to get interesting features.

Unification of classical mechanics and quantum mechanics in unique conception of particle dynamics

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In quantum mechanics there is wave function, which is not connected with other conception of mechanics, and one needs to use quantum principles which explain properties of the wave function. Gas dynamics describes stochastic motion of molecules, and wave function is an attribute of gas dynamics [1], because it is expressed via gas dynamic variables. The reversed Madelung [2] problem has been solved [3]. It has been shown that the gas, whose molecules are interacted between themselves by means of the classical force field κ^l, $l = 0,1,2,3$, which changes the particle mass, is described by the Klein-Gordon equation. It means that the classical field κ^l is responsible for quantum effects. This field generates stochastic particles. Real space-time is discrete. But Riemannian geometry cannot describe discrete space-time, because the discrete Riemannian space-time is described by the geometry on lattice, were one cannot construct a particle world line. It should use the physical geometry, which is described by world function and only by world function. In the physical geometry the particle world line is described by broken line, consisting of rectilinear segments. Motion of free particle in the discrete physical geometry appears to be stochastic [4]. It is described by means of mathematical formalism of gas dynamics. In the Euclidean geometry and in geometry of Minkowski this formalism degenerates in the conventional formalism of classical mechanics. Mathematical formalism of mechanics in physical space-time geometry is more developed than conventional formalism of quantum mechanics. It admits one to investigate structure of elementary particles, whereas the conventional quantum formalism can describe elementary particles only as formless points. Besides, construction of extended general relativity in the framework of physical geometry leads to appearance of antigravitation which stops collapse of matter into black hole [5].

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A kinematical model interpretation of special relativity according to Dirac-like equation

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The special theory of relativity is based on two postulates. The theory leads to unifying the space and time in a single combination (spacetime). The relativistic quantum mechanics combines the quantum mechanics and the special theory of relativity as two separated theories of different origins.

To derive an equation analogy to Dirac equation form without aid of quantum postulates, it was proposed (Sanduk, 2017a) a model based on a complex vector:] .

$$\mathcal{Z} = \boldsymbol{b} \exp i(\boldsymbol{k} \cdot \boldsymbol{r} - \omega t) = b\hat{\boldsymbol{e}}_r \exp i\,(\boldsymbol{k} \cdot \boldsymbol{x} - \omega t)\,. \tag{1}$$

Where $\boldsymbol{b}$ is a real radial vector. The obtained derived Dirac equation form is:

$$i\frac{\partial \mathcal{Z}}{\partial t} = (-i\,c\boldsymbol{A} \cdot \boldsymbol{\nabla} + B\omega)\mathcal{Z}\,, \tag{2}$$

Where $\boldsymbol{A} = \mp\, i\,\hat{\boldsymbol{e}}_\theta$ and $B = \pm 1$. Equation (2) describes the evolution process of the function $\mathcal{Z}$. Then, the quantity inside brackets of equation (2) has the form of Dirac Hamiltonian. This equation is for a motion in a complex plane. The second time derivative of equation (2) leads to an equation analogy to the Klein-Gordon equation.

The structure of complex vector (equation (1)) can be considered with aid of Euler's formula in a trigonometrical form (Sanduk, 2017b). That leads to assume a general real algebraic form for the Euler's formula:

$$\boldsymbol{r} = \mathscr{b}\left\{\cos\,(\boldsymbol{k}_2 \cdot \boldsymbol{s} - \omega t) \pm \sqrt{-sin^2(\boldsymbol{k}_2 \cdot \boldsymbol{s} - \omega t) + X}\right\} \tag{3}$$

Where X a real dimensionless quantity. This form is for position vector of a point in system of two rolling circles of radii a_1 and a_2. In addition to that

$a_2 = 1/k_2$, $\mathscr{b} = a_1 + a_2$ and $= a_1/\mathscr{b}$. Elimination of X $(X = 0)$ can be obtained within a case of partial observation (Sanduk, 2012) of the system. That means the small circle cannot be recognised. Then equation (3) transforms to equation (1). Time differentiation of equation (3) is an equation of velocity. This form does not show any relationship with Dirac equation form, but Dirac equation and Hamiltonian forms (equation (2)) can be restored when $X = 0$. The second time differentiation shows an analogy of Klein-Gordon equation.

As a conclusion, the analogical kinematical model shows that forms of quantum and special relativity may be referred to same origin. An analogy to Lorentz factor is found:

$$\gamma_s = \frac{1}{\sqrt{1 - \frac{v_g^2}{v^2}}}. \tag{4}$$

Where v_g and v are the speed of a point in the system, and the speed of the system.

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Variable speed of light in vacuum

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We assume the spacetime foam picture in which vacuum is filled with virtual wormholes. In the presence of an external electromagnetic or gravitational field the distribution of wormholes changes. We consider an anisotropic distribution of virtual wormholes induced by an external field and analyze its relation to the speed of light. We show that speed of light acquires an anisotropic character and save the normal dispersion a gas of virtual wormholes may possess also an anomalous dispersion, i.e., when the light velocity exceeds that in the vacuum.

Переменная скорость света в вакууме

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Рассмотрена модель пространственно-временной пены, в которой вакуум заполнен газом виртуальных кротовых нор. В присутствии внешнего электромагнитного или гравитационного поля распределение кротовых нор изменяется. Рассмотрен пример индуцированного внешним полем анизотропного распределения виртуальных кротовых нор и исследуется связь такого распределения со скоростью света. Показано, что скорость света в такой среде приобретает анизотропный характер и кроме нормальной дисперсии, газ виртуальных кротовых нор может обладать также и аномальной дисперсией - когда скорость света в среде превышает скорость света в вакууме.

Search for gravitational lenses along the first cosmic string candidate

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Cosmic strings are the linear topological defects which could have formed in the early Universe in phase transitions of the vacuum. The existence of cosmic strings does not contradict to modern observational data (space missions WMAP and Planck), although cosmic strings are still not discovered. Despite the complexity of the cosmological scenario about the cosmic strings, that still stands in the way of a complete understanding; a promising strategy is described here, aimed at detecting these elusive physical entities.

Our procedure is a mix of the two main methods of the cosmic string search.

The first one is the analysis of anisotropy of the CMB radiation. So, moving cosmic string due to the Doppler effect creates a specific form of the anisotropy on the surface of last scattering. Having a step-like structure, this anisotropy can be found by convolution of the radio maps (WMAP and Planck) with a set of orthogonal step functions. This method has allowed to identify several cosmic strings' candidates, the most reliable of which (Cosmic String candidate No. 1 = CSc-1) has an amplitude of anisotropy at 40 μK.

The second method is the search of the strong gravitational lensing effects of remote sources by a string.

A remote source (a galaxy) behind the cosmic string at a certain angular distance from it, generates two gravitational-lens images, characterized by identical spectra, identical redshifts and the special morphological features.

In a previous work the convolution of WMAP and Planck CMB radio maps by the modified Haar functions provided a list of preliminary CS candidates with the amplitude 40 μK. For the best one (CSc-1) covering a field of 11.7^{o} X 1°, we carried on an independent optical analysis, based on the search of sources of strong gravitational lensing. Using a photometric criterion we identified 42 lens candidates. This number seems convincingly in excess over the density of strong gravitational lenses in ordinary fields (a good hint for presence of a cosmic string). From the final catalog of the all close pairs of object in each optical field we estimated the mean deficit angle $3.5'' \leq \Delta\Omega \leq 6.5''$; so the CSc-1 velocity is $0.4c \leq v \leq 0.7c$. The accurate confirmation of the gravitational nature of the lens candidates must be done by their spectra. We plan to do it as well as to continue the study of the spectral and morphological features of the lens candidates along the CSc-1.

The discovery of cosmic strings would serve as the first observational investigation of the fundamental theory of superstring, and would also weed out a number of theoretical models of the early Universe.

Поиск событий гравитационного линзирования в поле кандидата в космическую струну

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Космические струны – линейные топологические дефекты, которые могли образоваться в ранней Вселенной в результате фазовых переходов вакуума. Существование космических струн не противоречит существующим наблюдательным данным (космические миссии WMAP и Planck). Космические струны до сих пор не обнаружены. Несмотря на трудности космологических сценариев образования космических струн, в работе приводится перспективная стратегия поиска этих неуловимых объектов. Процедура основана на совместном и взаимодополняющем использовании двух основных методов поиска космических струн. Первый метод: анализ анизотропии микроволнового реликтового излучения.

Так, движущаяся космическая струна за счет эффекта Доплера создает характерную форму анизотропии на поверхности последнего рассеяния. Обладая ступенчатой структурой, такая анизотропия может быть выявлена сверткой карт радио данных со спутников WMAP и Planck с набором ступенчатых ортогональных функций специального вида. Этот метод позволил отождествить несколько кандидатов в космические струны, самый надежный из которых (CSc-1) обладает амплитудой анизотропии в 40 μK.

Второй метод: поиск характерных событий сильного гравитационного линзирования.

Так, далекий источник (галактика) находясь позади струны на определенном угловом расстоянии от нее, порождает два гравитационно-линзовых изображения, характеризующихся одинаковыми спектрами, одинаковыми красными смещениями и характерными морфологическими особенностями.

В предлагаемой работе для кандидата CSc-1 была исследована полоса 11.7^{o} X 1° с целью поиска характерной цепочки событий гравитационного линзирования далеких галактик на предполагаемой струне. Используя фотометрические критерии, было обнаружено 42 кандидата в гравитационно-линзовые события. Их количество избыточно по сравнению с обычными событиями гравитационного линзирования, что служит хорошим указанием в пользу наличия в исследуемом поле космической струны. По 42 кандидатам был оценен дефицит угла CSc-1: $3.5'' \leq \Delta\Omega \leq 6.5''$, а также ее скорость $0.4c \leq v \leq 0.7c$. Окончательный ответ на вопрос о том, является ли CSc-1 космической струной, может быть дан при анализе спектров 42 объектов. Это

план на будущую работу, включая детальный морфологический анализ найденных кандидатов в гравитационные линзы в поле CSc-1.

Открытие космических струн послужило бы первым наблюдательным следствием теории фундаментальных суперструн, а также позволило бы отсеять ряд теоретических моделей ранней Вселенной.

Particle in a gravitational field

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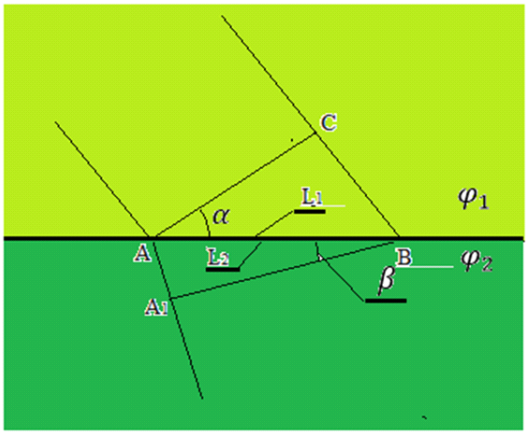
A number of processes of events occurring behind horizon is investigated in the book "Scalar model of gravitation", published by German academic publishing house Lambert Academic Publishing in 2015. It is research has allowed explaining all features of a spectrum of quasars. The mechanism of an exit of radiation because of horizon of events remained a little studied. The given work eliminates the specified blank. It is shown that movement occurs according to a principle of the least phase. It is shown also that the processes connected with a meteor shower, create atmosphere in a quasar vicinity. Dispersion of photons in quasar atmosphere returns a part of photons on ascending trajectories and allows them to fall outside the limits gravitational radius.

Refraction of The De Broglie wave in the thin layer dividing areas with different potential is connected with distinction of phase speeds, distinction of corresponding intervals of time and distinction of standards of length in areas with different potential. Therefore the relation of legs of a triangle (Fig.) equally $\frac{CB}{AA_1} = \frac{c_{f1}t_1}{c_{f2}t_2} = \frac{\upsilon_2}{\upsilon_1}e^{-\Delta\Phi}$ Hypotenuse also has different length in different areas. $\frac{(AB)_2}{(AB)_1} = e^{-\Delta\Phi}$ Thus, the refraction factor is expressed by the formula. $n = \frac{sin\alpha}{sin\beta} = \frac{CB}{(AB)_1}\frac{(AB)_2}{AA_1} = \boxed{\frac{\upsilon_2}{\upsilon_1}e^{-2\Delta\Phi}}$ The received formula allows calculating curvature of a trajectory in the field of transition. $K = \frac{d\alpha}{dl} = \left(\frac{1}{c^2} + \frac{1}{\upsilon^2}\right) g sin\alpha$



The knowledge of curvature of a trajectory allows receiving the equation of movement the general for photons and for massive particles. $\boxed{\frac{d\vec{P}}{dt} = m\vec{g} + \vec{\Omega}_g \times \vec{P}}$ $\Omega = \frac{d\alpha}{dl}\frac{dl}{dt} = K\upsilon$ Radius of curvature of photons $\boxed{R_c = \frac{c^2}{2gsin\alpha}}$ less than gravitational radius. Therefore, photons do not reach horizon of events in absence of collisions. The atmosphere connected with falling of meteorites disseminates a part of photons and returns them on ascending trajectories. For achievement of horizon of events enough such ten scatterings. The account of orbital speeds of stars in galaxies has allowed calculating density of a radial meteor shower and has confirmed conformity and communication with capacity of thermal and x-ray radiation of quasars. The investigated processes in a vicinity of quasars change the metrics of space of the Universe and explain observable scattering of galaxies.

The Independent navigation and system of co-ordinates

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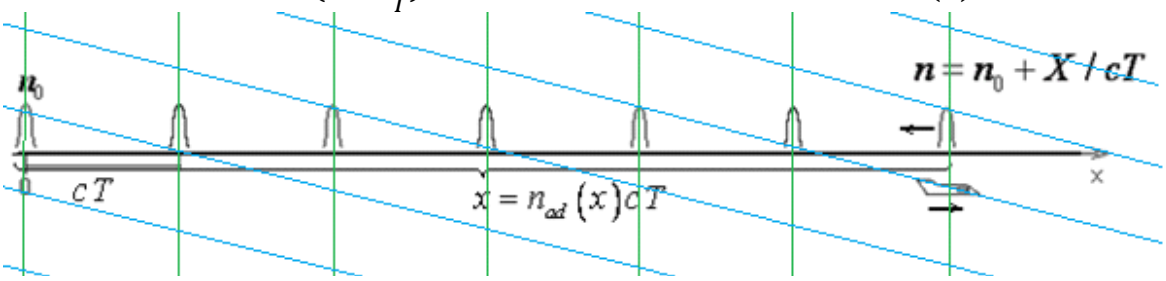
The principle of independent definition of co-ordinates of the spaceship concerning the chosen inertial system of co-ordinates is stated.

The modern system of space navigation includes both onboard, and external (being on other space vehicle or a heavenly body) measuring devices and computing means. Such system of space navigation cannot be used on distant space travel because of duration of distribution of a signal.

The offered system of independent space navigation is based on the account of impulses from four pulsars. The number of the impulses registered by the counter of the spaceship from the moment of start depends on ship co-ordinates. The further the ship from origin of co-ordinates, the more impulses is between the ship and origin of co-ordinates. These impulses are already registered by the counter of the ship and not registered by the counter in origin of co-ordinates. Number of such additional impulses of equally difference of the registered impulses and time divided into the period of following of impulses concerning the chosen co-ordinate system.

$$n_{ad}(x) = n - \frac{t}{T} \qquad (1)$$

$$x = cT(n - \frac{t}{T}) \qquad (2)$$



For calculation of co-ordinates, it is possible to use a chronometer and impulse meters from three pulsars or only impulse meters from four pulsars. In the latter case, it is necessary to solve linear equation system $n_i = \frac{t}{T_i} + \frac{R_i}{cT_i}$. Or in the matrix form

$$N = AX \quad (3)$$

$$X = A^{-1}N \quad (4)$$

It is shown that orientation on co-ordinates (4) is equally reliable both at movement in flat, and in curve space.

Some solutions for scalar models and conformal invariance

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It is well known that the conformal field theories in the Euclidean space have solutions for the equations of motions with the finite action. Such solutionswith the finite action are called instantons. A famous example is BPST-instanton in Yang-Mills theory with SU(2) gauge group and the topological number equals 1. We consider the scalar field theories with the conformal invariance on the Riemannian manifold. It is found instantons for some manifolds.

Let us consider $d = 4$ conformal scalar model in Euclidian space with the follow action

$$S = \int \left(\frac{1}{2}\partial_\mu\varphi\,\partial_\mu\varphi - \lambda\varphi^4\right) d^4x$$

Fubini-Lipatov instanton for this model is solution of the field equation

$$\Box\varphi + 4\lambda\varphi^3 = 0, \varphi_{FL} = \sqrt{\frac{2}{\lambda}}\frac{a}{(x-x_0)^2+a^2}.$$

Note that suchanequation of motion appears in some substitution for Yang-Mills equations with SU(2) gauge group. The self-duality equations are obtained when λ is zero. Solutions of the Laplace equation describe multi-instantons.

Fubini-Lipatov instanton is important in cosmology. See [1] for connection of tunneling effect in cosmology and instanton in conformal theory. Let us consider the conformal scalar theory in the Riemann space with metric $\boldsymbol{g^{\mu\nu}}$

$$\mathbf{S} = \int \left(\frac{1}{2}g^{\mu\upsilon}\partial_\mu\varphi\partial_\upsilon\varphi + \frac{1}{6}R\varphi^2 - \lambda\varphi^4\right)\sqrt{g}d^4x$$

where $\boldsymbol{R}$ is the Ricci scalar.

We can obtain solution of the field equation here using a conformal transformation for conformally flat manifolds. For example, for sphere $\boldsymbol{S^4}$ simplest solution is constant function. Itis useful to note that the actions for flat case and for case the sphere coincide.

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Конформная инвариантность и некоторые решения в скалярных теориях поля

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Хорошо известно, что конформные теории в евклидовых пространствах имеют решения уравнений движения с конечным действием. Такие решения с конечным действием называются инстантонами. Знаменитый пример – это БПШТ-инстантон в теории Янга-Миллса с SU(2) калибровочной группой и топологическим зарядом равным 1. Мы рассмотрим скалярные теории поля с конформной инвариантностью на римановом многообразии. Найдены инстантоны для некоторых многообразий.

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Radial acceleration relation and dissipative dark matter

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Observations indicate that ordinary matter, the baryons, influence the structural properties of dark matter on galactic scales. One such indication is the radial acceleration relation, which is a tight correlation between the measured gravitational acceleration and that expected from the baryons. In particular, a recent comprehensive study of about 153 different types of galaxies indicates that the mentioned radial acceleration relation has the form $g = \frac{g_B}{1-e^{-\sqrt{g_B/a_0}}}$ where g is the acceleration of a test mass in a galaxy, g_B is the gravitational field strength created by

only the baryonic matter of the galaxy at the same location, and $a_0 = (1.20 \pm 0.02 \pm 0.24) * 10^{10}\ ms^2$ is an empirical constant.

Such acceleration relation was initially motivated by modified Newtonian dynamics (MOND), which was originally posed as an alternative to dark matter. The empirical correlations that rotation curve measurements show with baryon content can be explained with the above given relatively simple one-parameter formula within the MOND framework. Dark matter theories must reproduce this, and other galactic scaling relations (within measured uncertainties), if they are to describe nature.

However, the observed correlations of rotation curve shapes with baryon content in galaxies, which the radial acceleration relation is an indicator, is an interesting challenge for dark matter theories. This seems to be particularly relevant to the oft-considered case of dark matter consisting of collisionless (or weakly interacting) particles. In particular, the correlations are observed to hold in gas-rich dwarf irregular galaxies which are dark matter dominated at all radii. It is hard to envisage how baryons, which are gravitationally insignificant could have such a large influence on the structural properties of the dark matter, if gravity was the only interaction with ordinary matter.

Dissipative dark matter is a specific kind of dark matter candidate that actually requires nontrivial interactions with baryons for a consistent picture of dark matter in rotationally supported galaxies. A generic such model involves considering a dark sector consisting of dark matter particles coupled with a massless dark photon. A theoretically constrained case is mirror dark matter which involves a duplicate set of particles and forces with exactly the same fundamental parameters (particle masses and coupling constants) as the standard particles and forces.

Such dark matter is dissipative and if the cooling rate is sufficiently strong the dark matter can collapse into a disk on time scales much less than the Hubble time. However, in the presence of heating such dark matter could, in principle, exist in an approximately spherical pressure supported halo. This is the scenario that we consider.

In such models the only viable heat source identified is that from ordinary supernova, which can become an energy source for the dark sector if small kinetic mixing interaction between photon and dark photon does exists. This kinetic mixing facilitates halo heating by enabling ordinary supernovae to be a source of the dark photons. These dark photons can transport a large fraction of a supernova's core collapse energy to the halo if the kinetic mixing magnitude is as large as 10^{-9}.

Such strongly interacting dark matter can be modelled as a fluid governed by Euler's equations. The halo is dynamical, being able to expand and contract in response to the heating and cooling processes. It is envisaged that for a sufficiently isolated galaxy its halo can evolve into a steady state configuration which is in hydrostatic equilibrium and heating and cooling rates are locally balanced. These conditions determine the temperature and density profile of the dark matter halo around such disk galaxies.

We show in this work that the dark matter density profile that has been motivated by dissipative dark matter models, including mirror dark matter, can

approximately reproduce the empirical radial acceleration relation. The paper was published in Phys. Rev. D 95 (2017), 023009.

Соотношение для радиального ускорения и диссипативная темная материя

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Наблюдения показывают, что обычное вещество, барионы, влияют на структурные свойства темной материи на галактических масштабах. Одним из таких проявлений является сотношение для радиального ускорения, которое представляет собой корреляцию между измеренным гравитационным ускорением и ожидаемым ускорением только от барионов. В частности, недавнее всестороннее исследование около 153 различных типов галактик показывает, что упомянутое сотношение для радиального ускорения имеет вид $g = \frac{g_B}{1-e^{-\sqrt{g_B/a_0}}}$где g – ускорение пробной массы в галактике, g_B– напряженность гравитационного поля в том же самом месте, создаваемая только барионным веществом галактики, и $a_0 = (1.20 \pm 0.02 \pm 0.24) * 10^{10}\ ms^2$ является эмпирической константой.

Первоначально такое сотношение для ускорения было предсказано модифицированной Ньютоновской динамикой (MOND), которая изначально мыслилась как альтернатива темной материи. Эмпирические корреляции с содержанием барионов, присутствуюшие в измеренных кривых вращения галактик, можно объяснить приведенной выше относительно простой однопараметрической формулой в рамках MOND. Теорий темной материи должны воспроизвести это и другие галактические эмпирические сотношения (в пределах неопределенностей измерений), если они претендуют описывать природу.

Однако наблюдаемые корреляции форм кривух вращения с содержанием барионов в галактиках, на которых указывает сотношения для радиального ускорения, представляют собой серьезный вызов для теорий темной материи. Это, по-видимому, особенно верно для часто обсуждаемого случая темной материи, состоящей из бесстолкновительных (или слабо взаимодействующих) частиц. В частности, корреляции наблюдаются и в богатых газом карликовых нерегулярных галактиках, в которых темная материя доминирует на всех масштабах. Трудно представить себе, как гравитационно незначительное количество барионов могло бы столь сильно влиять на структурные свойства

темной материи, если гравитация является единственным взаимодействием между темной и обычной материями.

Диссипативная темная материя – это особый вид темной материи, который на самом деле нуждается в нетривиальных взаимодействиях с барионами для согласованной картины темной материи в вращательно поддерживаемых галактиках. В общем случае такая модель включает в себя темный сектор, состоящий из частиц темной материи в сочетании с безмассовым темным фотоном. Теоретически хорошо обоснованый случай диссипативной темной материи – это зеркальная темная материя с дублированным набором частиц и сил с точно такими же фундаментальными параметрами (массы частиц и константы связи), что и стандартные частицы и силы.

Такая темная материя диссипативна, и если скорость охлаждения достаточно велика, темная материя может схлопнуться в диск на временных масштабах гораздо меньше, чем время Хаббла. Однако при наличии нагрева такая темная материя могла бы, в принципе, существовать в виде приблизительно сферического гало, где равновесие обеспечивается давлением. Это иммено тот сценарий, который мы рассматриваем.

В таких моделях источником тепла могут быть обычные сверхновые, которые могут стать источником энергии для темного сектора, если существует небольшое кинетическое смешивание между фотоном и темным фотоном. Это кинетическое смешивание приводит к нагреванию гало, позволяя обычным сверхновым быть источниками темных фотонов. Эти темные фотоны могут перенести в гало значительную часть энергии коллапса ядра сверхновой, если величина кинетического смешивания порядка 10^{-9}

Такая сильно взаимодействующая темная материя может быть смоделирована как жидкость, управляемая уравнениями Эйлера. Гало становится динамичным, способным расширяться и сокращаться в ответ на процессы нагрева и охлаждения. При этом для достаточно изолированной галактики ее гало может эволюционировать в устойчивую конфигурацию, которая находится в гидростатическом равновесии, и скорости нагрева и охлаждения локально сбалансированы. Эти условия определяют профили температуры и плотности гало темной материи вокруг таких галактик дискового типа.

В данной работе мы показываем, что профиль плотности темной материи, который был мотивирован диссипативными моделями темной материи, включая зеркальную темную материю, может воспроизвести эмпирическое соотношение для радиального ускорения. Работа опыбликована в Phys. Rev. D 95 (2017), 023009.

Geometric aspects of quantum mechanics

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Modern quantum mechanics arose as a concept necessary for interpreting the results of three groups of experiments performed about a hundred years ago (later they were substantially modified and complicated).

1. Investigation of the radiation spectrum of a heated body led Planck to the hypothesis of discrete radiation quanta, and the energy of such a quantum turned out to be related not to the squares of the frequency and amplitude of some vibrational or wave process, but to the first power of its frequency.
2. The regularities of the spectral terms and the result of Rutherford's experiment on the scattering of α particles led Bohr to specific postulates, the first of which was consistent with the idea of the wave properties of a bound electron in atom, and the second with the concepts of quanta of emitted radiation.
3. The results of experiments on the scattering of electrons by crystals ("double-slit experiment") led de Broglie to the hypothesis of an electron possessing wave properties.

A self-consistent interpretation of all these circumstances was suggested by Schrodinger, who declined to describe the microsystem and its behavior using classical concepts. Instead, he introduced the concept of a "wave function" that satisfies certain differential equations. The properties of these equations and their solutions turned out to be suitable for describing the results of experiments, and the limiting transition was consistent with the classical results.

It is not difficult to see that at each stage of the formation of quantum mechanics, volitional assumptions of a paradoxical nature took place. The lack of visual meaning for the wave function and some of its properties, as well as the involvement of the ideas of probability theory into physical theory, constitute the conceptual problem of quantum mechanics that has achieved remarkable success in applications. Nevertheless, there are experiments that require the introduction of new paradoxical hypotheses.

From what has been said, it follows that, whatever the hypotheses and postulates, a different concept based on them should, at the very least, also explain these and other experiments. Such a concept may be Clifford's idea that there is no way to distinguish experimentally the effect of force fields and the manifestation of the geometric properties of the experiment space. In the case of gravity, this idea was realized by Einstein, and a number of problems that arose when GRT is applied on galactic scales were similarly overcome in [1]. Features of the mathematical apparatus make it possible to extend the geometric approach to other cases [2]. The integers arising in the experiments in the processing of data indicate the need to use waves, but do not require the existence of physical waves, since these data arise as a

result of a self-consistent measurement procedure. Therefore, the introduction of the periodic component in the definition of the metric tensor allows us to arrive at equivalent results, although it disrupts the usual ideas about the dynamics of the microworld.

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Геометрические аспекты квантовой механики

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Современная квантовая механик возникла как концепция, необходимая для интерпретации результатов трех групп экспериментов, выполненных около ста лет назад (в дальнейшем они существенно модифицировались и усложнялись).

1. Исследование спектра излучения нагретого тела привело Планка к гипотезе о дискретных квантах излучения, причем энергия такого кванта оказалась связана не с квадратами частоты и амплитуды некоторого колебательного или волнового процесса, а с первой степенью его частоты.
2. Закономерности спектральных термов и результат опыта Резерфорда по рассеянию α-частиц привели Бора к постулатам, первый из которых был согласован с представлениями о наличии у связанного электрона волновых свойств, а второй с представлениями о квантах испускаемого излучения.
3. Результаты опытов по рассеянию электронов на кристаллах (“двухщелевой эксперимент”) привели де Бройля к гипотезе о наличии у электрона волновых свойств.

Самосогласованную интерпретацию всех этих обстоятельств предложил Шредингер, который отказался от описания микросистемы и ее поведения с помощью классических понятий. Вместо них он ввел понятие “волновой функции”, удовлетворяющей некоторым дифференциальным уравнениям. Свойства этих уравнений и их решений оказались пригодны для описания результатов опытов, а предельный переход соответствовал классическим результатам.

Нетрудно видеть, что на каждом этапе формирования квантовой механики происходили волевые допущения, носившие парадоксальный характер. Отсутствие наглядного смысла у волновой функции и некоторых ее свойств, а также вовлечение идей теории вероятностей в физическую теорию составляют концептуальную проблему квантовой механики, достигшей замечательных

успехов в приложениях. Тем не менее, имеются эксперименты, требующие введения новых парадоксальных гипотез.

Из сказанного следует, что какими бы ни были иные гипотезы и постулаты, иная концепция, построенная на их основе должна, как минимум, также объяснять эти и другие эксперименты. Такой концепцией может быть идея Клиффорда о том, что не существует возможности опытным путем отличить действие силовых полей и проявление геометрических свойств пространства эксперимента. В случае гравитации эта идея была реализована Эйнштейном, а ряд проблем, возникших с применением ОТО на галактических масштабах, был сходным образом преодолен в [1]. Особенности математического аппарата позволяют распространить геометрический подход и на другие случаи [2]. Целые числа, возникающие в экспериментах при обработке данных, указывают на необходимость использования волн, однако не требуют существования физических волн, поскольку эти данные возникают в результате самосогласованной процедуры измерений. Поэтому внесение периодической составляющей в определение метрического тензора позволяет прийти к эквивалентным результатам, хотя и нарушает привычные представления о динамике микромира.

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Reflection and refraction electromagnetic waves at the dielectric surface: peculiarities interactions

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The problem of reflection and refraction at the interface of electromagnetic waves dielectric medium with different orientation of the polarization plane towards the plane of gravitation was solved. It is shown that the result of waves' reflection and refraction depends on the direction of the wave's polarization plane, on the angle of incidence and the relative refractive index of the medium.

The findings were checked on the available optical device. The observation of thin films' interference in reflected light for two types of plane-polarized waves in the plane of incidence (p-wave) and perpendicular to the plane of incidence (s-wave) showed that with all observed angles of incidence the s-wave phase, reflected from a more optically-dense medium becomes opposite. For p-waves the change of the wave

phase depends on the angle of incidence, that coincides with Fresnel equations' analysis.

The research of the way the electromagnetic wave (EM-wave) passes and reflects the interface is practically required in creation of measuring circuit aiming to disclose remote space objects as well as to study the space radiation spectrum. In this regard it should be noted that Fresnel equations played a significant role as they helped to solve a number of important issues in physics. First of all, this is the problem of outlooks on the nature of light. Fresnel equations finally determined that the light is a wave, and, what is more, it is a s-wave. Secondly, this is the problem of luminiferous aether. The light considered to travel within that aether, wherein agitations occur and they are the light. Many scientists sought to derive Fresnel equations using different aether properties. This led to the creation of the elasticity theory. Finally, the analysis of formulas themselves has considerably expanded the understanding of how different substances pass the interface with the light as well as the way the light travels within the interface.

It is known that when the light wave is reflected from more optically-dense medium ($n2 > n1$), like in case with an interference figure in the parallel-sided plate experience, another optical path difference in $\lambda/2$ occurs. However, such a statement is not always fair. When the reflection of the polarized light happens, the polarization plane of incident radiation and the angle of incidence should be taken into account. There are requirements for EM-waves to be reflected from the dielectric surface that are mentioned in the work [1]. To derive Fresnel equations the method of EM-waves modeling through the Heaviside layer was used. The representation of EM-waves as the Heaviside layer (a square wave) is essential not just experimentally, but theoretically, as it allows to address many tasks without monochromatic waves usage that is generally accepted [2].

In this paper the analysis of EM-waves' reflection was conducted. The polarization surface of these waves that coincides with the incidence plane (p-wave) and the polarization of these waves that is perpendicular to the incidence plane (s-wave) are studied, as well as the ratio rate of refraction on interface. A special attention in Fresnel formulas is paid to changes of a wave phase while passing with the light the interface of 2 dielectrics, including the light penetration into another medium with total internal reflection.

The correlation of a reflected wave' electric-field strength to an incident wave shows that a reflected wave always has the same phase as the incident one, notwithstanding the mediums' image density [1]. That is to say that there is no change of a reflected wave phase. The analysis also shows that when the reflection from more optically-dense medium happens, a reflected s-wave phase changes to π, at the same time a reflected p-wave phase does not change with the angle of incident from 0 to $\alpha_{Б,}$ but it changes to π with the angle of incident from $\alpha_Б$ to $\pi/2$. While reflecting from optically less-dense medium, a reflected s-wave phase does not change, a reflected p-wave phase changes to π with the angle of incident from 0 to $\alpha_Б$ and does not change with the angle of incident from $\alpha_Б$ to $\pi/2$.

To verify the findings [1] an experiment with the goniometer aiming to observe Newton interference rings in reflected light for s- and p-waves was conducted. It

showed that for many angles of incidence, when the polarizer identifying s- or p-waves turned, the interference figure did not change. Just on angles of incidence, that were close to the Brewster angle, the change of interference minimums to interference maximums was seen when the polarizer turned in a centre of interference figure. This is a testimony to a change of path-length difference to $\lambda/2$ and of the phase to $-\pi$, that indicates the calculations fairness.

The proposed methodology of the phase change' registration and of the polarized EM-wave that was reflected from the interface can be used in monitoring of space objects and in particular of their displacement. The availability and reliability of interferential measurement circuit allows to improve instrumentations' accuracy and unambiguity.

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Properties of the Spatial -Temporary Continuum and the Entropy

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Four-dimensional space-time is manifested by the motion of matter. The laws of conservation of energy, momentum and angular momentum was formulated in classical mechanics. This laws represent the property of the space-time continuum to preserve isotropy and linearity. Local physical laws are symmetric in time, but the sheer asymmetry of time is observed at macroscopic level.

Usually, entropy is considered in connection with the thermodynamic probability and quantum discreteness of the state. Entropy is determined by a part of the phase space (phase volume), thus, the entropy is determined by the coordinates and momentum of the particles entering the system. It is not necessary to use the time when describing a conservative system. The law of conservation of energy in the phase space is sufficient to describing a conservative system. The growth of entropy always hinders the ordering of the system, provides energy dissipation and homogenization of the system. But there are also inverse processes in open systems. Reduction of entropy due to the maintenance of heterogeneity by external forces. In this case there is a flow of entropy which is directed to the environment.

On the other hand, the possibility of the existence of a perturbation of the gravitational field where the velocity varies (the transverse vector velocity wave), but not the density of matter, follows from the Einstein equations of the general theory of relativity. Perturbations of velocity lead to a probabilistic character of the motion of inertial frames. The ergodic hypothesis unites the fluctuations in the kinetic characteristics of the system and time.

The principle of equivalence combines motion and gravity. Cosmic objects can be considered as dissipative systems in dynamic equilibrium. This objects has the bifurcation character of the transition from one state to another. The evolution of the dissipative system turns out to be irreversible due to a change in the phase volume. Thus, the time and the entropy are associated by irreversibility. Consequently, entropy as a form of motion energy contributes to the formation of cosmic structures as well as gravitational forces. Relic radiation and chaotic motion are forms of entropy. In space, perhaps, there are both gravitational waves and motion waves. So, we can assume that it is the entropy that balances the energy of gravity.

Свойства пространственно-временного континуума и энтропия

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Четырехмерное пространство-время проявляется как движение материи. Законы сохранения энергии, импульса и момента импульса, сформулированные еще в классической механике, представляют такие свойства пространственно-временного континуума как способность в целом сохранять изотропность и линейность. Локальные физические законы симметричны по времени, но на макроскопическом уровне наблюдается явная асимметрия по времени.

Энтропию принято рассматривать в связи с термодинамической вероятностью и квантовой дискретностью состояния. Энтропия определяется частью фазового пространства (фазовым объемом), и определяется координатами и импульсами частиц, входящих в систему. Для описания консервативной системы время не нужно достаточно закона сохранения энергии в фазовом пространстве. Рост энтропии всегда препятствует упорядочиванию системы, обеспечивает диссипацию энергии и приводит к однородности и гомогенизации системы частиц. Но существуют и обратные процессы в открытых системах возможно уменьшение энтропии за счёт поддержания неоднородности внешними силами и возникновением потока энтропии направленном в окружающую среду.

А, с другой стороны, из уравнений общей теории относительности Эйнштейна следует возможность существования возмущений, в которых наряду с гравитационным полем испытывает изменение скорость, но не

плотность материи (поперечная векторная волна скорости). Возмущения скорости приводят к вероятностному характеру движения инерциальных систем отсчета. Эргодическая гипотеза связывает флуктуации кинетических характеристик системы и время.

Принцип эквивалентности объединяет движение и гравитацию. Космические объекты можно рассматривать как диссипативные системы находящиеся в динамическом равновесии и с бифуркационным характером перехода из одного состояния в другое. Эволюция диссипативной системы оказывается необратимой из-за изменения фазового объема. Таким образом, через необратимость время оказывается связано с энтропией. Следовательно, энтропия как вид энергии движения вносит вклад в формирование космических структур соизмеримый с гравитаций. Энтропия, присутствует в пространстве не только в виде реликтового излучения, но и как хаотическое движение. А учитывая тот факт, что вместе с гравитационными волнами могут существовать волны движения, то не исключено, что именно энтропия уравновешивает энергию гравитации.

Viscous fluid cosmological model in $f(R,T)$ gravity

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In this paper, we have studied the role of the bulk viscosity in modified theory of gravity. The gravitational action of modified gravity contains general functions f (R, T) gravity, where R and T, respectively denote the curvature scalar and the trace of the energy momentum tensor. Within the frame work of Bianchi VI_h metric, of the form

$$ds^2 = dt^2 - A^2dx^2 - B^2e^{2x}dy^2 - C^2e^{2hx}dz^2,$$

Where A, B and C are the function of cosmic time t. The exponent h decides the behavior of the model and can take the integral such as -1, 0, 1.

Power law cosmology has been widely studied in recent times because of its functional simplicity and ability to provide fast information about the nature of the universe. In general context the power law cosmology is defined by their growth of the cosmological scale factor as a(t)α t^m, where a(t) is scale factor and m is arbitrary constant. The observed expanding stage of the universe is described by m>0: for m<0 we have a contracting universe (t>0). The behavior of the power law cosmology is completely describe by the Hubble parameter $H = \frac{\dot{a}}{a}$ and the deceleration parameter $q = \frac{-\ddot{a}a}{\dot{a}^2}$.

In this work, we have taken the linear form $f(R,T) = \lambda(R+T)$, (λ is any arbitrary constant) rescale the modified gravity theory. We have investigated three different models corresponding three values of the metric parameter, that is -1, 0, 1.

The dynamics behavior of the model is studied for a presumed power law expansion of the volume scale factor along with energy conditions of the model.

Yang-Mills equations and gauge coupling constants

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In the traditional approach in the Yang-Mills theory, the gauge coupling constants are included in the covariant derivative and therefore are presented in the definitions of physical quantities. It is more correct to include the coupling constants not in the covariant derivative, but in the field term of Lagrangian density. Then the system of physical quantities is determined by purely mathematical relationships without empirical coupling constants. It is this approach that mathematicians prefer (L.D. Faddeev, A.A. Slavnov, and others). Also the physicist F. Wilczek used a similar system of quantities to show the geometric meaning of coupling constants. Such geometrical approach achieves completion by introducing a physical quantity *the concentration of the potential*. Originally this quantity was introduced by J.C. Maxwell in the framework of classical electrodynamics, which allowed him to express the equations of electrostatics, and then electrodynamics in a linear form (with Coulomb gauge). Later J.W. Gibbs gave a geometric interpretation of Laplacian of the physical quantity as a *dispersion* of this quantity, equal to the Maxwellian concentration with the negative sign. The concepts of Maxwell and Gibbs are naturally generalized within the 4-dimensional Minkowski spacetime as the 4-concentration (dispersion) of the potential, which leads to the linear form of the equations of classical electrodynamics. The introduction of an analogous quantity in the Yang-Mills theory also leads to the fact that all differential relations are presented only into the definitions of physical quantities without any empirical constants, and the Yang-Mills equations are expressed as a linear relationship between the concentration (or dispersion) of the potential and the current density with the empirical coupling constant as the coefficient of proportionality.

Уравнения Янга-Миллса и калибровочные константы связи

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При традиционном подходе в теории Янга-Миллса калибровочные константы связи включаются в ковариантную производную и поэтому присутствуют в определениях физических величин. Более правильно константы связи включать не в ковариантную производную, а в полевой член плотности лагранжиана. Тогда система физических величин определяется чисто математическими соотношениями без эмпирических констант взаимодействий. Именно такой подход предпочитают математики (Л.Д. Фаддеев, А.А. Славнов и др.). Также физик Ф. Вильчек использовал аналогичную систему величин, чтобы показать геометрический смысл констант связи. Такой подход находит свое завершение при введении физической величины *концентрация потенциала*. Первоначально эту величину ввел Дж.К. Максвелл в рамках классической электродинамики, что позволило ему выразить уравнения электростатики, а затем и электродинамики в линейной форме (при кулоновской калибровке). Позже Дж.У. Гиббс дал геометрическую интерпретацию лапласиана физической величины как *дисперсии* этой величины, равной максвелловской концентрации с обратным знаком. Понятия Максвелла и Гиббса естественным образом обобщаются в рамках 4-мерного мира Минковского как 4-концентрация (дисперсия) потенциала, что приводит к линейной форме уравнений классической электродинамики. Введение аналогичной величины в теории Янга-Миллса также приводит к тому, что все дифференциальные соотношения входят только в определения физических величин без каких-либо эмпирических констант. При этом уравнения Янга-Миллса выражаются в виде линейного соотношения между концентрацией (или дисперсией) потенциала и плотностью тока с эмпирической константой связи как коэффициентом пропорциональности.

Self-organized isotropic vector matrix translation apparatus for realization of the electron, nucleon, and periodic system

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In Marius Sophus Lie's doctoral dissertation, *Over en Classe geometriske Transformationer* from 1871, he emphasizes its "intimate dependence on philosophical reflections upon the nature of Cartesian Geometry", where more specifically Plückers monumental idea to create new geometries by choosing figures other than points – in fact straight lines – as elements of space pervaded all of Lie's work. Cartesius equated the defining property, or 'essence', of material substance with three-dimensional spatial extension: "the extension in length, width, and depth which constitutes the space occupied by a body, is exactly the same as that which constitutes the body…consequently, there cannot exist a space separate from body, since all spatial extension simply is body". In Lie's geometrical projection, "straight lines of length equal to zero" were thus understood to build up not only his infinitesimal transformation groups and algebras but jointly and likewise the fabric of the physical world from the very ground. We have therefor made a corresponding implementation of the Killing *Würzeldiagram* A_2 of SU(3), which in duplication by its unit *t* isospin root vectors renders a faithful geometrical, so called *octet truss* isotropic vector matrix (IVM) realization of the structure of real space as a trigonometrically determined phase transition between the infinitesimal generators of orthogonal and spherical symmetry. It is a lattice where the latter, diagonally inclined root vectors by a 12-step convolution of one octahedron/two tetrahedrons composition within successive parallelepiped outlines of the parent Euclidean space form a train of cloverleaf "grains of nature" as Buckminster Fuller called them, and whose space-filling geodesics can thus be found by the continuous close-packing of their parallelepiped cages that can iterate and hierarchically expand the coverage over the local plane to the global scale. The solution is a trapezoid module of $152 + 1$ blocks, that in recursive outlay of itself walls in a central unit pivot gap which shadows the process with an inertial relation of $1/[(152 + 1)\, x\, 12] = 1/1836$ which is precisely the electron/proton mass ratio. This *Aufbau* system has further bearings, inter alia to the periodic system as will be exemplified here, and to the organization of logic including neuronal and language formation. It is thus a significant fact that Mendeleev originally moulded his two-dimensional rendering of the periodic system on the dual Sanskrit grammar/phonetics.

The generalized spin connection for gravitational and electromagnetic interactions

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The minimal interactions of the matter with gauge fields is discussed by the local extention of the global Noether symmetries. The minimal interactions of the matter with gauge fields is discussed by the local extention of the global Noether symmetries of the matter. In field theory, the matter fields are represented as the definite eigenstates of the mass, charge and spin. The gauge theory of gravitation is obtained by the local extention of the Poincare symmetry, P. It is partly a space-time symmetry group, translations in Minkowski space-time, and Lorentz rotations [SO(3,1)], and partly inner symmetry group of the fields, SU(1,1)×SU(2) frame rotations. However, the electromagnetism is obtained by the local extention of the inner symmetry group, U(1).

Since spin-0 fields do not have internal frames they are coupled to gravitation only by the space-time translations or the Lorentz rotations. Spin 1/2 fields are coupled to the gravitation by introducing the Fock- Ivananko connection or the spin connection. Since it appears together with the electromagnetic potential in the Lagrangien and field equations, the generalization of the spin connection to include electromagnetic potential was discussed by Schrödinger and Bargmann in their pioneering investigations. But in this generalization, all fields are coupled to spin-1 electromagnetic field by the identical charge.

In order to solve this problem and to derive a generalization of the spin connection with gravitational and electromagnetic fields, we search the global symmetries of the classical model of the zitterbewegung. In this model, the configuration space of the particle consists of the space-time coordinates, x^a in the Minkowski space-time, and the internal coordinates z in in four dimensional complex space. In terms of the proper time of the spinning particle, τ, the free particle Lagrangian is given as

$$L(x^a, p_a, \bar{z}, z; \tau) = \frac{1}{2i}\left(\frac{d\bar{z}}{d\tau}z - \bar{z}\frac{dz}{d\tau}\right) - p_a\left(\frac{dx^a}{d\tau} - \bar{z}\gamma^a z\right)$$

The Lagrangian is invariant under the following transformations:

$$x'^a = (1 - i\zeta^c P_c - i\varepsilon^{cd} L_{cd})x^a,$$

$$z_k{}' = exp\left[-i\varphi 1 - \frac{i}{2}\varepsilon^{cd}\Sigma_{cd}\right]_k^l.$$

In here, P_c, L_{cd} , $\frac{\Sigma_{cd}}{2}$ and 1 are the generators of the transformations. The invariance of L under these global transformations give the conservation of the momentum, p_a, the total angular momentum, $J_{ab} = L_{ab} + \bar{z}\frac{\Sigma_{ab}}{2}z$ and charge , $\bar{z}z$. Therefore, the electric charge is an internal conserved quantity like momentum and

the angular momentum. So spinning particle has 11 conserved quantities from these transformations. If we consider the translations in proper time of the particle we get one more independent conserved quantity, mass.

We consider the local gauge transformations such that

$$x'^a = \exp\left(-i\zeta^c(x)P_c - i\varepsilon^{cd}(x)L_{cd}\right)x^a,$$

$$z_k{}' = U_k^l(x)z_l\ , \ldots\ U(x) = exp\left[-i\varphi(x)1 - \frac{i}{2}\varepsilon^{cd}(x)\Sigma_{cd}\right].$$

Then, under these transformation the Lagrangien of the particle becomes

$$L\left(x^\mu, p_\mu, \bar{z}, z; \tau\right) = \frac{1}{2i}\left(\frac{d\bar{z}}{d\tau}z - \bar{z}\frac{dz}{d\tau}\right) - p_\mu\left(\frac{dx^\mu}{d\tau} - \bar{z}\gamma^\mu z\right) - \bar{z}\gamma^\mu z\bar{z}B_\mu z,$$

where, B_μ is the spin connection of the electromagnetic and gravitational interactions and given as

$$B_\mu = e_\mu^a\left(\varphi_{,a} + \frac{1}{2}\varepsilon^{cd}{}_{,a}(x)\Sigma_{cв}\right) = A_\mu + \Gamma_\mu,$$

and $e_\mu^a(x)$ are the tetrads

$$e_\mu^a(x) = (\delta_\mu^a + \zeta^a{}_{,\mu} + \varepsilon^{ac}{}_{,\mu}(x)x_c).$$

In the interaction Lagrangien, $\bar{z}\gamma^\mu z\bar{z}B_\mu z$, the spinning particle is coupled to vector potential, A_μ, by $\bar{z}z\bar{z}\gamma^\mu z$ and the coupling between the spinning particle and the gravitation is $\bar{z}\gamma^\mu z\bar{z}\Gamma_\mu z$.

By using this generalized spin connection, we derive the nongeodesic equation of the spinning particle and discuss the limits of it in the Minkowski space-time, Riemann –Cartan space-time and Weitzenbock space-times.

The analysis of frequency-independent jumps of cmb according to the planck data

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This research contains the time analysis of jumps of a spectral density of *CMB*. As the purpose of the analysis serves searching of the directions on the celestial sphere along which existence of these jumps does not depend on the frequency of the accepted radiation.

For the analysis data multi-channel Planck's data were used. These data are obtained on nine independent channels in two frequency ranges from 30 *GHz* to 70 *GHz* and from 100 *GHz* to 857 *GHz*. At the same time in four years multiple the spectral density of a luminosity was exposed to measurements in more than 12 million directions on the celestial sphere. The published results are integral data on eight cycles of measurements by duration on half a year. Angular resolution in the directions of the celestial sphere made about ten angular minutes.

The analysis of statistical distributions of differences of semi-annual data showed existence in them of the jumping changes of intensity reaching a half of its

range more both in positive and in the negative direction. The analysis of statistical distributions of differences of semi-annual data showed existence in them of the jumping changes of intensity reaching a half of its range more both in positive and in the negative direction. The probability of emergence of the jump corresponding to the selected region of distribution in some direction on the celestial sphere, for example, at a frequency of 30 *GHz* makes about $8 \cdot 10^{-4}$.

Then at independence of emergence of jumps on each of the frequency ranges the probability of jump in some direction on the celestial sphere both at a frequency of 30 *GHz*, and at the following frequency of 44 *GHz* of low-frequency range makes $7 \cdot 10^{-7}$. In other words, as 30 *GHz* so 44 *GHz* of such directions on the celestial sphere will be in regions of the distributions which are falling into to frequencies only eight.

If to add the analysis of tails of distribution for the third range of a low-frequency strip to consideration, then at independence of emergence of jumps between these three frequency ranges the probability of emergence of jump in some direction on the celestial sphere at all three frequencies makes $6 \cdot 10^{-10}$. The probability of detection of one such direction among twelve million directions is negligible.

However, during the analysis more than 160 such directions were revealed. Excess of the found number of such directions over their number which was calculated, proceeding from independence of jumps between channels of observations can demonstrate course of certain physical processes which cause splashes in a spectral density of a luminosity of radiation. At the same time the result of such influence in rather wide frequency range is not depending on radiation frequency. In favor of such conclusion grouping of some of the revealed directions on celestial spheres in clusters about one long angular degree testifies.

The received conclusions can be confirmed by means of searching of the found jumps of a spectral density of a luminosity of *CMB* in a strip of the high frequencies of the probe Planck making 100 *GHz*, 143 *GHz*, 217 *GHz*, 353 *GHz*, 545 *GHz*, 857 *GHz* at permission approximately five angular minutes that corresponds to more than 48 million independent directions on the celestial sphere. Besides, there is a possibility of checking according to ten channels of the *WMAP*'s data at five frequencies of 23 *GHz*, 33 *GHz*, 41 *GHz*, 61 *GHz*, 94 *GHz*.

Influence of large-scale inhomogeneity of gravitational field of the Universe on photons of relict radiation can be referred to such physical processes. This influence can be realized as on the surface of the last scattering (not integrated Sachs-Wolf's effect), and between the surface of the last scattering and Earth (the integrated Sachs-Wolf's effect). In particular, if in the Universe relativistic substance dominates (for example, photons) or dark energy, then a spatial distribution of a gravity potential can quickly change and, in turn, slightly change energy of the photons of relict radiation passing through it.

Gravitational interaction in geometric and relational paradigms

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Analysis of modern research in the field of fundamental theoretical physics shows that they are conducted within the framework of three metaphysical paradigms: field-theoretical (dominant), geometric and relational, in which the nature of the three key physical categories: space-time, particles (bodies) and fields of interaction curriers. The most complete understanding of physical reality can be obtained only with the ability to look at it from all three mentioned paradigms.

In the field-theoretical paradigm, the fields and particles are described by differential equations (within the framework of the short-range interaction concept) against a background of a priori given space-time.

In the geometric paradigm, to which the general theory of relativity belongs and its many generalizations, the category of space-time is combined with the category of fields of interaction curriers, whereas the third category (particles) has an independent character, taken into account in the form of the energy-momentum tensor on the right side of the Einstein equations. In this approach, electromagnetic and other interactions are represented in the form of specific generalizations of gravity. In this paradigm, the most fruitful are multidimensional geometric models such as the Kaluza theory.

In the relational paradigm, the foundations of which were laid in the writings of G. Leibniz and E. Mach, space-time does not have an independent status, but is treated as an abstraction from the relationship between events. The relational paradigm is based on three factors: 1) the relational interpretation of the nature of space-time; 2) the description of interactions based on the concept of long-range action; and 3) the justification of the local properties of objects (particles) by the influence from the outside world (the Mach principle).

The relational approach to the universe develops on the basis of the mathematical theory of unary and binary systems of relations, which is based on: presetting one (or two) sets of elements, the existence of paired relations between them (real or complex), the assumption of an algebraic law linking paired relations between elements, and the postulate of fundamental symmetry.

In the framework of the theory developed on this basis, a number of fundamentally important results were obtained, in particular: 1) substantiation of the dimension and signature of physical space-time was given; 2) quadratic character of the metric was explained; 3) two types of representations were proposed: coordinate and impulse, 4) a justification is given for the spinor nature of elementary particles,

5) a secondary character of the gravitational interactions due to electromagnetism is shown, 6) another interpretation of the cosmological redshift is proposed, and so on.

The report proposes outlining the main principles of the theory of systems of relations, describing on this basis, the gravitational interactions and showing the way of obtaining the listed results.

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Гравитационное взаимодействие в геометрической и реляционной парадигмах

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Анализ современных исследований в области фундаментальной теоретической физики показывает, что они ведутся в рамках трех метафизических парадигм (миропониманий): теоретико-полевой (доминирующей), геометрической и реляционной, в которых по-разному трактуется природа трех ключевых физических категорий: пространства-времени, частиц (тел) и полей переносчиков взаимодействий. Наиболее полное представление о физической реальности может быть получено лишь при умении смотреть на нее со стороны всех трех названных парадигм.

В теоретико-полевой парадигме поля и частицы описываются дифференциальными уравнениями (в рамках концепции близкодействия) на фоне априорно заданного пространства-времени.

В геометрической парадигме, к которой принадлежит общая теория относительности и ее многочисленные обобщения, категория пространства-времени объединяется с категорией полей переносчиков взаимодействий, тогда как третья категория (частиц) имеет самостоятельный характер, учитываемый в виде тензора энергии-импульса в правой части уравнений Эйнштейна. В этом подходе электромагнитное и иные взаимодействия представляются в виде своеобразных обобщений гравитации. В данной парадигме наиболее плодотворными представляются многомерные геометрические модели типа теории Калуцы.

В реляционной парадигме, основания которой были заложены в трудах Г. Лейбница и Э. Маха, пространство-время не имеет самостоятельного статуса, а трактуется как абстракция от отношений между событиями. Реляционная парадигма опирается на три фактора: 1) реляционная трактовка природы пространства-времени, 2) описание взаимодействий на основе концепции дальнодействия и 3) обоснование локальных свойств объектов (частиц) воздействием со стороны окружающего мира (принцип Маха).

Реляционный подход к мирозданию развивается на базе математической теории унарных и бинарных систем отношений, в основу которой положены: задание одного (или двух) множеств элементов, наличие между ними парных отношений (вещественных или комплексных), предположение о наличии алгебраического закона, связывающего парные отношения между элементами, и постулат фундаментальной симметрии.

В рамках развиваемой на этой основе теории получен ряд принципиально важных результатов, в частности: 1) дано обоснование размерности и сигнатуры физического пространства-времени, 2) объяснен квадратичный характер метрики, 3) предложено обоснование двух видов представлений: координатного и импульсного, 4) дано обоснование спинорного характера элементарных частиц, 5) показан вторичный характер гравитационных взаимодействий, обусловленный электромагнетизмом, 6) предложена иная интерпретация космологического красного смещения и т. д.

В докладе предполагается изложить основные принципы теории систем отношений, описать на этой основе гравитационные взаимодействия и показать путь получения перечисленных результатов.

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Solar Flare, Prominence, Sunspot Cycle—in Terms of Magnetism

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Documents show that the Sun's magnetic field strength distributes itself differently across the surface of the Sun. At its polar field, the strength is found to be 1-2 gauss, whereas it is typically 3,000 gauss in areas where sunspots populate, and 10–100 gauss in solar prominences.

The above field strength distribution thus reveals to us the following typical features: (1) the field strength at areas near the equator is far stronger than that near the polar area and the difference is literarily out of proportion; (2) while the field is strong near the equator, it is further concentrated at where the sunspots show up; (3) number of the sunspots in our vision displays no direct proportional relationship with the overall strength at where they show up; (4) that 10–100 gauss is found in solar prominences conversely means that the field strength of each sunspot is comparatively weak until some chance is introduced together with a prominence.

Features (1) and (2) can be hypothetically realized by such an arrangement: A strong magnetic bar is placed deep below the surface of the Sun and this bar always has its pole pointing near the equator, but never at either of the Sun's poles. Feature (3) removes the possibility that the strong magnetic strength near the equator is solely contributed by the sunspots; therefore this reasoning further emboldens a believing that a separate magnetic source other than the sunspots owns this strong field. Being not the source, however, the sunspots appearance can serve as an index to help tracing how this source has been moving. Is it only coincidence that sunspot never appear at the pole where the magnetic strength is so weak? Feature (4) further witnesses that each sunspot is a weak magnet compared to the one hypothetically assumed existing far behind the Sun's surface.

A separate and pronounced magnetic body deep below the Sun's surface and speculated above seems highly inevitable as derived in *How the Sunspots' Material Nature Affects Its Activity Cycle—in Terms of Gravitation*, by *Cameron Wong.* Reasoning based on observation presented in this article should lead us to believe that the Sun is consisted of three basic layers: (1) the outmost layer, which, in a state of plasma, is the layer in our daily view, and is called the fluidic crust of the Sun in that article; (2) deep below this crust is a zone that hosts the absolute major nuclear reactions of the Sun; (3) further below the nuclear reaction zone is the Sun's core volume of the Sun, a spheroidal volume of exceedingly high mass density. This spheroidal dense volume is called the yolk of the Sun in that article. This yolk is embraced by innumerous nuclear reactions, which happen all over on the yolk's surface in an isotropic manner with respect to the center of the Sun. Floating on this dense massive yolk is a gigantic magnetic material body (**MMB**), which should have

contained no less mass than all the sunspots put together, and its material nature should be essentially the same as that of the sunspots.

Floating on the yolk with mass far exceeding what our Earth has, this MMB cannot escape from the governing action exerted on it by the gravitational force from the planets, particularly Jupiter. Being a gigantic magnetic carrier, its whereabouts must in turn orchestrate the debuting and hibernation of the population of those magnetic sunspots through magnetic reaction. In comparison to this giant MMB, each sunspot is merely a magnet droplet, even if such droplet may reach a volume as big as 1000 times of the Earth. From this thread of reasoning, let's further pursue how the MMB and each sunspot are to form various magnetic "tube" that guides the appearance of prominence, solar flare, and subsequently the coronal mass ejection.

How the sunspots' material nature affects its activity cycle in terms of gravitation

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No material we know of on Earth can withstand the temperature of nearly 6,000 ^{o}k found on the surface of the Sun and still stay in one stable structure as how the sunspots show. The heaviest element Osmium has a mass density of 22.6g/cm^3 with a boiling point of 5285 ^{o}k, above which no one stable piece of osmium can be found. The next material found with higher mass density than osmium is neutron stars. All these potentially lead us to believe that sunspots are composed of material of mass density far higher than osmium. But what is its material nature?

With volumes that can reach even 1,000 times of that of the Earth, together with the unusually high mass density, the sunspots must have response to the gravitational influence from all the planets conspicuously different from the fluidic materials in their environment. The gravitational influence from the planets on the Sun is just an inescapable reciprocal response to the gravitational force from the Sun onto the planets. Therefore, as part of the Sun, the sunspots must be responsible of the exertion of the influence as well as sharing the corresponding reciprocal response from the planets.

When the size of the sunspot is mentioned in our study, we have been getting used to a concept that is portrayed by terms like contract, expand, and decay. If gravitational influence from the planets cannot be excluded in a reasonable speculation, we may have to include one more concept that is portrayed by the term "buoyance". As such, the visual effect of contracting in our view happens when a sunspot sinks deeper and deeper below the Sun's surface, whereas the visual effect of expanding happens when the sunspot resurfaces and exposes itself more and more in our view. So, given the unusually high mass density of the sunspots, true decaying of them in the sense of material integrity may not be a reality that our study can pursue.

Looking at whether the sunspots should have response to the gravitational influence from the planets, we cannot escae from the awareness of two numbers that are very close in value. One of them is the more or less than 11 year beat of the rhythm shown by the maximum and minimum of the sunspot population; the other is the 11.86 year period of Jupiter's orbital movement. In case the gravity of Jupiter does have influence on the cycle of sunspots, what about other planets? Further, we must be aware of that **the Sun's spinning axis tilts by an angle of 7.5^{o}** with respect to the ecliptic, but when a solar maximum begins, the initial few spots always show up near the 45° latitude, north or south. Will then the Sun's axial tilt also play a role in affecting the sunspot cycle?

The Highly Collimated Jet Stream of Quasars

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Basic facts common to quasars:

(1) Highly compact both in mass and energy,

(2) Having a supermassive material center,

(3) Excluding the material center, the general existence of mass is in a state of plasma,

(4) Rapidly spinning,

(5) Periodical variation in luminosity,

(6) Highly remotely located from Earth with high value of redshift.

Besides the above common facts, a high percentage of quasars are also found containing jet streams. The strange thing is that the jet always comes in pair, with one from the pair pointing in the opposite direction of the other, and both jets are highly collimated.

As far as we know on Earth, to create highly collimated beams of light or particles, technology must rely on lenses, be they optical, mechanical, or electrostatic. Beams that can travel even in the order of millions of light years and still retain its high collimation in many cases should be beyond what artificial lens can handle, let alone that the lens must be able to withstand the destructively high energy that the lens must let through.

As a thumb of rule, the higher the energy content in any physical entity is found, the higher chance of randomness is associated with this entity. Special filtering mechanism must present for some orderly output of anything to come out of this entity. Without a lens-like arrangement, how would the jet stream of a quasar be made stay highly collimated and must appear in pair? Would this paring have anything to do with the quality of collimation in our interest? In other words, must the collimation rely on some mechanism that produces the pairing? Or, if no pairing, the jet stream would not be formed at all? In nature, it is so common that action and

reaction always coexist, so do matter and anti-matter, as well as electric and magnetic poles. How should we relate the phenomenon shown by the jet pair of opposite directions from the philosophical aspect but in terms of physical interaction?

In modern science, when high energy and high speed are involved, it has been so natural for us to apply Einstein's relativity to explain many puzzles that classic physics may appear failing to explain. Have we been applying relativity in a blemish free manner in explain all phenomena that we observe from quasars, particularly those caused by blazars? The questions seem endless. But it is those questions that have impelled this article to put up an effort for a more in-depth investigation.

Bosons and the black hole

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The problem of the linkage of black hole and bosons was investigated. We have considered the Shvartzshild's black hole.

It was considered bosons mixture in and out of the black hole. The base bosons were gravitons and photons.

So bosons form broaden horizon, it was necessary evaluate size of this layer and its structure. The layer is bridge between black hole and galactic gas and it has temperature distribution. We have analyzed the distribution and its evolution.

The internal structure of elementary particles is considered. We have proposed the string models of the particles and calibrations bosons such as photon, $W^{\pm}$ and Z^0 bosons, gluon and graviton.

It is supposed the Dirac's constant $\hbar$, the light velocity c and the gravitation constant G aren't functions of time. Opposite possibility is analyzed in work of one of authors (Yurasov N.I. (PIRT-2007)). There it is demonstrated the time variations of $\hbar$, c and G are very small in our time and we may ignore them. Therefore the Plank's volume isn't function of time and we may use it as constant.

We have discussed opposite case shortly (for charge oscillations of graviton (antigraviton)).

The Plank's length is equal unity of length in string model of particles.

Using relativistic quantum mechanics the internal structure of the particles is constructed. We have taken account the Schrodinger's trembling and some particularities of string model. Also we have used global properties of our Metagalactica and black holes. This program is indispensable part of analyzing of bosons composition of the broaden horizon.

We have formed dynamic string models of bosons and have discussed dynamic string models of fermions.

Also we discussed the string mechanism of radiation emission and linkage between gravity and electrodynamics on base of string model.

There are presented the Feynman's diagrams for gravitons and photons and it is analyzed the threshold energy of the processes.

We have considered possibility of pairs formation for bosons and them condensation in and near black hole also and have evaluated temperatures of critical points.

Spectrum of gravitation waves from black hole is analyzed. We have discussed particularities of the spectrum using string model. We have taken account the evolution of broaden horizon of black hole.

Internal structure of black hole was considered and it were discussed different possibilities.

We have discussed the problem of stability of black hole.

Бозоны и чёрная дыра

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Была исследована проблема связи чёрной дыры и бозонов. Мы рассмотрели чёрную дыру Шварцшильда.

Рассмотрена смесь бозонов вне и внутри чёрной дыры. Основными бозонами были гравитоны и фотоны.

Так как бозоны формируют расширенный горизонт, необходимо оценить толщину этого слоя и его структуру. Этот слой является мостом между чёрной дырой и галактическим газом и он имеет температурное распределение. Мы проанализировали это распределение и его эволюцию.

Рассмотрена внутренняя структура элементарных частиц. Мы предлагаем струнные модели частиц и калибровочных бозонов таких как фотон, $W^{\pm}$ и Z^0 бозоны, глюон и гравитон.

Предполагается, что дираковская постоянная $\hbar$, скорость света c и гравитационная постоянная G не являются функциями времени. Противоположная возможность проанализирована в работе одного из авторов (Юрасов Н.И. (PIRT-2007)). Там продемонстрировано, что временные изменения $\hbar$, c и G очень малы в наше время и мы можем их не учитывать. Поэтому планковский объём не является функцией времени и мы используем его как постоянную.

Мы кратко обсудили противоположный случай (для осцилляций заряда гравитона (антигравитона)).

Планковская длина равна единицы длины в струнной модели частиц.

Используя релятивистскую квантовую механику, сконструирована внутренняя структура частиц. Мы учли шредингеровское дрожание и некоторые особенности струнной модели. Также мы использовали глобальные

свойства нашей Метагалактики и чёрных дыр. Эта программа является необходимой частью анализа бозонного состава расширенного горизонта.

Мы сформировали динамические струнные модели бозонов и обсудили динамические струнные модели фермионов.

Также мы обсуждаем струнный механизм испускания излучения и связь между гравитацией и электродинамикой на базе струнной модели.

Представлены фейнмановские диаграммы для гравитонов и фотонов и проанализирован энергетический порог процессов.

Также мы рассмотрели возможность образования пар бозонов и их конденсацию в и вблизи чёрной дыры и оценили температуры критических точек.

Проанализирован спектр гравитационных волн от чёрной дыры. Мы обсудили особенности спектра, используя струнную модель. Мы учли эволюцию расширенного горизонта черной дыры.

Была рассмотрена внутренняя структура чёрной дыры и были обсуждены различные возможности.

Мы обсудили проблему стабильности чёрной дыры.

Phenomenological Aspects of Asymptotic Safe Gravity

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The singularity theorems of Hawking and Penrose erased the hope that spacetime singularities in classical General Relativity are just a consequence of the high degree of symmetries assumed in the collapse or in the energy momentum tensor.

Now we know that the appearance of spacetime singularities is a proof of the limit of validity of General Relativity. An important property of any serious attempt to quantize gravity is the ability to resolve the break down of physics in these singular regions of spacetime.

Loop Quantum Gravity and spin foam models manage to solve this problem since they assume that the spacetime is intrinsically discrete. Concerning models on continuous spacetimes, one interesting proposal is that of Asymptotic Safety Program.

Asymptotic Safety (AS) framework for quantum gravity keeps the same fields and symmetries with General Relativity and studies the associated gravitational action as a fundamental part of the complete theory, at the nonperturbative level (with the help of functional renormalization group (RG) techniques).

The key idea behind the AS scenario was first proposed by Weinberg. The central requirement is the existence of a non-Gaussian fixed point (NGFP) of the renormalization group (RG) flow for gravity. If this NGFP exists, this defines the behavior of the theory at the UV. Furthermore, in this regime all measured quantities are free from nonphysical divergences!

Asymptotic safe gravity does not emerge from a direct quantization of General Relativity. The Einstein Hilbert action is a bare action that corresponds to a non-trivial fixed point of the RG flow and is a prediction assuming asymptotic safety.

The AS framework justifies someone to work with the gravitational effective average action which includes only the effect of the quantum fluctuations with momenta $p^2 > k^2$. Thus the effective average action represents an approximate description of physics at the momentum scale $p^2 \approx k^2$. In this way, it is possible to develop following various different paths, a phenomenological study of asymptotic safety.

The scope of this work is to investigate the structure of spacetime at high energies and in particular both in the vicinity of the center of spherically symmetric solutions and in the big bang regime of cosmological solutions. Both these type of solutions are generated from quantum modified Einstein equations according to the AS framework.

The present paper has two targets. First, we analyze the properties of recently found non singular spherically symmetric and cosmological solutions. Secondly, we present a novel improved version of modified Einstein equations according to the Asymptotic Safety idea. The proposed new equations are compatible with a new more natural scheme for energy conservation.

The way we will produce these new modified Einstein equation valid for short distance interiors of spherically symmetric configurations and early times cosmologies, follows. AS framework uses a system of truncated RG flow equations that contains two running couplings, the gravitational constant $G(k)$ and the (positive) cosmological constant $\Lambda(k)$. Near the non-Gaussian UV fixed point the coupling G approach zero, while on the other hand, the coupling Λ behaves as the square of the momenta. Due to this scaling of G, Λ in the UV regime we work on the belief that in the Big bang regime and in the center of black hole the Λ term plays the dominant role. Thus, we study the modified Einstein vacuum equations where only $\Lambda(k)$ appears. More precisely, the result of the existence of the non-Gaussian fixed point at the UV is utilized, This allows us to adopt the scaling behaviour of $\Lambda \sim k^2$

With a running cosmological constant as the source, novel uniquely defined covariant gravitational equations that modify minimally the Einstein gravity are derived. They are constructed so that the Bianchi identities are satisfied by construction. We first have to find the appropriate covariant kinetic terms that support an arbitrary source term $\Lambda(k)$ without any symmetry assumption and construct modified Einstein equations which respect the Bianchi identities. If we add a spacetime-dependent cosmological constant $\Lambda(x)$ in the 4-dimensional vacuum Einstein equations so that $G_{\mu\nu} = -\Lambda g_{\mu\nu} + 8\pi G T_{\mu\nu}$, obviously, this equation does not satisfy the Bianchi identities. Thus, we will add an energy-momentum tensor $\vartheta_{\mu\nu}$to

support $\Lambda(x)$, so that the Bianchi identities are satisfied. This formalism has the advance that allows the term $\Lambda(x)$ to be kept arbitrary (later we will specify the function $\Lambda(x)$). The novel scheme of energy conservation is given by the Bianchi identities which now take the form $\vartheta_{\mu\nu}^{;\mu} = \Lambda_{;\nu} - 8\pi(G(T_{\mu\nu})^{;\mu} + T_{\mu\nu}G^{;\mu})$, where; denotes covariant differentiation with respect to the Christoffel connection of $g_{\mu\nu}$.

The third Einstein's relativity and Planck's warning

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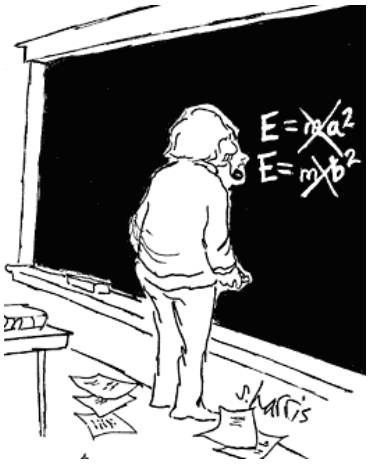

The Special and General relativity theories suggest different descriptions of our space-time; still both are engaged in physics – in different parts. There's a third theory which in a sense (in the symmetry group of its equations) is a sort of synthesis of SR and GR; some features of this theory are touched here.

Einstein was continuing to seek a better theory – that would go beyond General relativity (and Special relativity as well) and possess the next features and properties:

1. Geometrical meaning of all interactions, not only gravity, including quantum mechanics (the existence of different interpretations of QM means that no one interpretation is fully convincing and cogent).

2. No arbitrary parameters ('was there a choice?'); 'constants' should be a sort of global, slowly varying parameters of a solution, not of the theory itself.

3. Solutions (of general position) to the theory should be eternal and not break down on singularities; let's add: they should not become 'boring'/primitive; i.e., the trivial solution should be (linearly) unstable.

One such an attempt was dealing with field equations of the frame field $\boldsymbol{h^a}_{\boldsymbol{\mu}}$; the symmetry group of these equations brings together the symmetry groups of both SR (the Lorentz group acting on Latin indices) and GR (the group of coordinate diffeomorphisms, Greek indices)*. So, in this theory we have the Lorentz group (it defines the space-time signature) without inertial coordinates. This theory inspired Pauli's famous phrase: '[Einstein's] never-failing inventiveness as well as his tenacious energy guarantees us in recent years ...' [1, p.347]. Pauli asked also reasonable questions – concerning the energy-momentum tensor and post-Newtonian corrections. Einstein also could not answer these questions, and wrote in a letter: 'You were right after all, you rascal' (Sie Spitzbube) [1, p. 347].

In 1913, when Einstein only began searching for the right theory of gravity, Planck said him [1, p.329]: "As an older friend I must advise you against it for in the

first place you will not succeed; and even if you succeed, no one will believe you." It seems Planck was right: GR is only a low-scale approximation, invalid on galactic scales (huge amounts of Dark Matter are required, while many observations, on scales 100 kpc – 1 Gpc, should be ignored) [2], and even Einstein lost belief in his next good theory.

It turns out that, among the compatible equations (second order systems; they all, like the vacuum equation of GR, are nonlinear), there is an exceptional frame field equation [3], non-Lagrangian, with D = 5, that meets the above mentioned requirements 2, 3, and possibly 1. Considering prolonged equations of fourth order, it is possible to easily obtain a D-momentum tensor and a reasonable 4-th order gravitation theory [3] which seemingly does not need dark matter and dark energy (those prolonged equations can also be obtained through a Lagrangian quadratic in the field equations), see [3] and references therein.

This equation gives rise to a new worldview where "particles" are a sort of topological superstructure (non-linear field configurations carry topological charges and quasi-charges) over a classical understructure, with a set of 15 degrees of freedom (polarizations). These polarizations are very different – both in their functions and, tremendously, in amplitudes, as three of them are linearly unstable (but these three, and many others, do not contribute to the D-/angular momentum). The longitudinal polarization gives rise to an O_3-symmetrical ultra-relativistically expanding cosmology, with a simple Hubble diagram:
$\boldsymbol{\mu = \mu_0 + 5log\,[(1+z)\,ln(1+z) + O(\Gamma^{-2})]}$ (Γ is the relativistic factor of expansion).

The interactions of classical polarizations and topological (quantum) degrees of freedom in this mathematical world should be very interesting, and, perhaps, important for better understanding of quantum mechanics as a phenomenological and incomplete (at least averaged along the extra-dimension) description of topological quanta on the very complicated, stochastic and expanding, classical background.

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* In other words, the theory inherits features of both SR and GR; nevertheless (maybe out of the spirit of contradiction, and due to other reasons) it was called differently – Absolute Parallelism.

Третья относительность Эйнштейна и предостережение Планка

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Специальная и общая теории относительности (СТО и ОТО) предлагают весьма различающиеся точки зрения на пространство-время, то есть они не могут обе быть абсолютно точными. Тем не менее, обе теории используются в физике, в разных ее разделах. Обсуждается теория, которая в определенном смысле (по имеющимся симметриям) объединяет СТО и ОТО, или является их синтезом.

Эйнштейн продолжал искать теорию, идущую дальше ОТО (и СТО), со свойствами:

1. Геометрически объясняет все взаимодействия (как ОТО – гравитацию), и кванты.
2. Не содержит произвольных параметров (“был ли у Бога выбор?”); “константы” это глобальные, “медленные” параметры решения, но не теории.
3. Её решения вечны, не обрываются из-за сингулярностей. Добавим, и не могут быть “скучными” (простыми); то есть тривиальное решение должно быть (линейно) неустойчивым.

Одна из таких попыток была связана с уравнениями поля реперов $h^a{}_\mu$; симметрия уравнений объединяет симметрии СТО (группа Лоренца, по латинским индексам) и ОТО (группа диффеоморфизмов, греческие индексы)*.

С этой теорией связана известная фраза Паули: “Неистощимая изобретательность г-на Эйнштейна гарантировала нам в последнее время ...” [1]. Паули также задал вопросы по делу – о тензоре энергии-импульса и постньютоновских поправках. Эйнштейн тоже не смог ответить на эти вопросы, и писал в письме: “Вы оказались правы, негодник!” [1, p.347].

В 1913 г., когда Эйнштейн только начинал поиски правильной теории гравитации, Планк высказывал предостережение [1, p.329]: “Как старший товарищ, должен предостеречь относительно такого выбора: во-первых, у вас не получится, а если даже получится, никто вам не поверит”. По-видимому, Планк оказался прав. ОТО это лишь приближение для “малых” масштабов, не работающее на галактических масштабах (для спасения ОТО нужно привлекать огромное количество темной материи, а также игнорировать ряд наблюдений на масштабах от 100 кпк до 1 Гпк, [2]). С другой стороны, сам Эйнштейн, после критики коллег, потерял веру в свою новую теорию.

Оказывается, среди совместных уравнений поля реперов (систем второго порядка; они нелинейные, как и вакуумное уравнение ОТО) все же обнаруживается [3] исключительный случай (с размерностью $D = 5$, нелагранжев), соответствующий требованиям 2-3, и, возможно, 1. Нужно

рассматривать продолженные уравнения, четвертого порядка (которые также можно получить из вариационного принципа, с лагранжианом квадратичным по уравнениям поля), чтобы придти к тензору энергии-импульса и уравнениям гравитации 4-го порядка [3]. В этой гравитации темные сущности (темная материя и темная энергия) уже, по-видимому, могут быть излишни.

Данный вариант теории приводит к новой картине мира, где элементарные частицы появляются как топологическая “надстройка” (нелинейные конфигурации поля могут нести топологические заряды и квази-заряды) над классическим основанием, включающим 15 степеней свободы (поляризаций). Эти поляризации очень различаются по функциям и свойствам, а также, в огромной степени, по интенсивности: три из них линейно неустойчивы (но они, как и ряд других, не дают вклад в энергию-импульс/момент импульса). Продольная поляризация способна обеспечить O_3-симметричную расширяющуюся космологическую модель (S^3-облочка), с простой диаграммой Хаббла (нет свободных параметров, кроме H_0): $\mu = \mu_0 + 5\log\left[(1+z)\ln(1+z) + O(\Gamma^{-2})\right]$

Взаимодействие классических и топологических (квантовых) степеней свободы в этом математическом мире должно быть интересным и, возможно, полезным для лучшего понимания КМ (как феноменологического описания топологических квантов на сложном, стохастическом фоне).

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* Это означает, что теория наследует ряд свойств СТО и ОТО; однако, из духа противоречия и по другим причинам, она была названа иначе – абсолютный параллелизм.

Geometric interpretation of fields and forces of inertia in the nature

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In the last 2016, the global physical community celebrates two anniversary events associated with the term theory of relativity. It is 100+10 years of, so called, special relativity theory and 100 years of, so-called, general relativity theory. In this regard, it is hardly possible to doubt that “it is the time to gather stones”, scattered at

the beginning of the last century, has come. The difficulties of the theory of relativity last century can be achieved by replacing the classical Riemann geometry to a more general geometry. The latter should include the previous as a special case [1]. In this way we come to the new physical results, in particular to the identification of the essence and role of inertial forces in the nature. According to modern concepts, symmetry is the primary, most profound tool for the physical description of nature. If we talk about the symmetries, which would determine the uniform, rectilinear motion, we share a certain point of view of R. Feynman, that "... the symmetry with respect to uniform rectilinear motion leads to the special principle of relativity ..." [2]. But what about the symmetries inherent to accelerated movements? Symmetries, inherent in the system determine the laws of conservation end the types of its interaction with its environment. What new symmetries "come into play" during the transition to the accelerated motions? What is their connection with symmetries of non-accelerated motions? To answer on these questions, we will consider class of symmetries rarely analyzed in the literature, which are called translations in momentum space $R^4(p)$ $p' = p - \pi$ (1). The 4-covectors p and π are the functions of the point $x = (t, \boldsymbol{r})$ in $R^4(x)$ space. The latter is dual (conjugate) to $R^4(p)$. This kind of symmetry called the translations in momentum space $R^4(p)$ [1]. Conversions (1) induce in the coordinate space $R^4(x)$ conversions $x' = \frac{x}{1-\pi(x)\cdot x}$ (2). As the parameters in (2) occur the components of 4-covector of $\pi = \pi(x)$ translations in the space $R^4(p)$. The aggregates of (1) and (2) are called the Caratheodory transformations [1]. They form a group, which is one of the subgroups of the group of projective transformations. Moreover, Caratheodory transformations leave invariant equations of motion and angles in $R^4(x)$. The vector of translations $\pi(x)$, is a continuous quantity. Equality to zero of $\pi(x)$ takes us back to the case of uniform motion, while its consistency leads to a description of uniformly accelerated motion. However, this is not all. The thoughtful reader will certainly notice that (2) is a ratio that describes the transfer characteristic of a feedback loop, which are dealt with in cybernetics and automatic control theory. In this case, the increment of $\pi(x)$ momentum is a control, whereas the increment of coordinates is an observed value. The scalar product of $\pi(x) \cdot x$ can take on both positive and negative values. Therefore, such a contour loop is universal. Depending on the magnitude and direction of the 4-momentum fluxes in the system or out of it, the contour loop has the ability to change the feedback, for example, the transition from positive to negative or vice versa.

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