6th International Conference on

Theoretical and Applied Physics

May 16-17, 2019 | Rome, Italy

Scientific Tracks & Abstracts
Day 1

SESSIONS

Theoretical, Experimental and Computational Physics | Astro-Particle Physics and Cosmology | Quantum Physics & Technology | Plasma Physics | Material Science & Engineering

Chair: Marie Duquesne, Bordeaux INP, France
Co-Chair: Oleg A Kharshiladze, Tbilisi State University, Georgia

SESSION INTRODUCTION

Title: Stability problem and simulation of interaction of the multidimensional NLS solitons in non-uniform and nonstationary media
Vasily Yu Belashov, Kazan Federal University, Russia

Title: Modeling of evolution and non-elastic interaction of solitary NLS envelop pulses in complex media
Oleg A Kharshiladze, Tbilisi State University, Georgia

Title: The effect of strains on electronic structures of group IV diamond like crystals – DFT based studies
Norbert Janik, Wroclaw University of Science and Technology, Poland

Title: A promising biosourced, organic phase change material for seasonal storage
Marie Duquesne, Bordeaux INP, France

Title: Explosion of collapsed supernova and hot big bang of the universe driven by magnetic monopoles
Qiuhe Peng, Nanjing University, China

Title: Heun equation and its uses in physics
Nasser Saad, University of Prince Edward Island, Canada

Vasily Yu Belashov et al., J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

Stability problem and simulation of interaction of the multidimensional NLS solitons in non-uniform and non-stationary media

Vasily Yu Belashov[1], **Oleg A Kharshiladze**[2] and **Jemal Rogava**[2]
[1]Kazan Federal University, Russia
[2]Tbilisi State University, Georgia

Investigation of dynamics of multidimensional electromagnetic (EM) waves in plasma, such as 2D and 3D envelop solitons, is very actual problem. The interaction sufficiently changes the characteristics of the waves and background EM field in the region of interaction. Problem of the dynamics and stability becomes more complicated if it is necessary to take into account an influence of different dispersive and nonlinear inhomogeneities and nonstationary parameters of medium on the soliton structure and evolution. In this case the problem reduces to the generalized nonlinear schrodinger (GNLS) equation for the amplitude of the EM field with coefficient functions having spatial and temporal inhomogeneities. The analysis of stability of the multidimensional GNLS solitons was based on the method of study of transformational properties of the Hamiltonian of the system developed by authors earlier for the BK class of the equations. As a result we have found the conditions of existence of the multidimensional stable GNLS soliton solutions. At simulation the Fourier splitting method for the GNLS equation was used taking into account the inhomogeneities of coefficient functions of the equation. Implicit scheme of finite-difference method was used for investigation of soliton propagation in non-uniform and nonstationary medium. Numerical modeling showed that inhomogeneity of medium changes the amplitudes of solitons and nonlinear EM waves, their velocities of propagation, their quantity that is caused by their nonelastic interaction in inhomogeneous medium. Nonstationary medium changes a form of impulse and affects its spectral features. Changes of modulation of the parameters of medium make possible variation of character of nonelastic interaction at solitons attraction-repulsion.

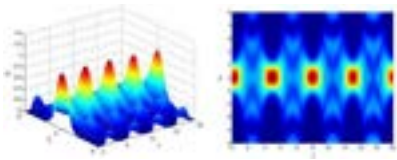

Figure 1: Strong stable pulsations of breather type in non-stationary medium with negative nonlinearity

Recent Publications

1. Belashov V Yu, Belashova E S and Kharshiladze O A (2018) Nonlinear wave structures of the soliton and vortex types in complex continuous media: theory, simulation, applications. Lecture Notes of TICMI. Tbilisi University Press 18:90.
2. 2. Belashov V Yu, Belashova E S and Kharshiladze O A (2018) Classification of multidimensional solitary solutions of the GKP equation by use of qualitative and asymptotic analysis. Journal of Physical Chemistry and Biophysics 8:38.

Biography

Vasily Yu Belashov has completed his PhD in Radio Physics and DSci in Physics and Mathematics. He is Chief Scientist and Professor at the Kazan Federal University. He was Coordinator of studies on the Intern. Program "Solar Terminator" (1987-1992), and took part in the Intern programs WITS/WAGS and STEP. He is author of 340 publications including 8 monographs. His main books are "Solitary Waves in Dispersive Complex Media. Theory, Simulation, Applications", "Solitons: Theory, Simulation, Applications".

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Oleg A Kharshiladze et al., J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

Modeling of evolution and non-elastic interaction of solitary NLS envelop pulses in complex media

Oleg A Kharshiladze[1], **Jemal Rogava**[1] and **Vasily Yu Belashov**[2]
[1]Tbilisi State University, Georgia
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Investigation of evolution and interaction of solitary waves and pulses (wave packets) is very actual problem in different fields of physics especially when the medium is non-uniform and its properties depend on time. In this case, as a model, we use the generalized non-linear Schrödinger (GNLS) equation, which describes the waves in a plasma, fiber and planar optical waveguides, taking into account the inhomogeneity and non-stationary of a propagation medium. Earlier we have shoved analytically that the GNLS equation can have stable and quasi-stable solutions of the soliton and breather types and also unstable solutions which disperse with time. In this paper we study the evolution and interaction of the envelop solitons numerically. At simulation the Fourier Splitting Method for the GNLS equation was used and the specially developed implicit scheme of finite-difference method was used for investigation of soliton like structures propagation in non-uniform and non-stationary medium. Numerical modeling showed that inhomogeneity of medium changes the parameters of the envelop solitons such as their amplitudes, velocities and their quantity that is caused by their non-elastic interaction in inhomogeneous medium. Non-stationary medium changes a form of pulses and affects their spectral features. Changes of modulation of the parameters of medium make possible variation of character of non-elastic interaction at solitons attraction repulsion. Obtained results can be useful in numerous applications in plasma physics, nonlinear optics and in many other fields of physics.

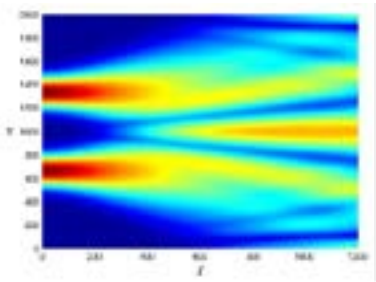

Figure 1: Evolution of double Gaussian envelop pulse in stationary medium with negative nonlinearity

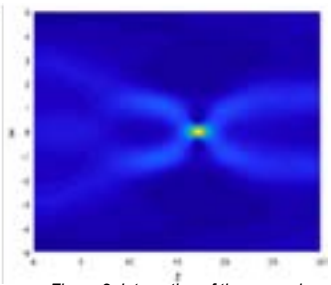

Figure 2: Interaction of three envelop pulses with formation of one strong pulse and its disintegration with time (negative nonlinearity)

Recent Publications

1. Belashov V Yu, Belashova E S and Kharshiladze O A (2018) Problem of stability of multidimensional solutions of the BK class equations in space plasma. Advances in Space Research 62:65-70.
2. Belashov V Yu, Belashova E S and Kharshiladze O A (2018) Nonlinear wave structures of the soliton and vortex types in complex continuous media: Theory, simulation, applications. Lecture Notes of TICMI. Tbilisi University Press 18:90.

Biography

Oleg A Kharshiladze is Associate Professor at Physics Department of Tbilisi State University. He is involved in International Scientific group, working on Analytical and Numerical analysis of Ionospheric and Magnetospheric processes (turbulence, shear flows, BBF and others).

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Norbert Janik et al., J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

The effect of strains on electronic structures of group IV diamond like crystals – DFT based studies

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Wroclaw University of Science and Technology, Poland

Materials composed of the group IV elements are promising candidates for designing the nano-optoelectronic devices integrated with Si based circuits. Special requirements concerning the electronic properties of the materials (direct band-gap, high mobility of carriers) can be met via the electronic structure engineering. One of methods of modifying the electronic structure is applying the strain [1, 2, 3], e.g. by the choice of unmatched lattices in epitaxial technologies. In this work the DFT based computational methods have been applied to investigate systematically the effect of strains on electronic structure, with the use of ABINIT program. In reference to available technologies the isotropic as well as uniaxial and biaxial strains for crystallographic planes (100), (110) and (111) in diamond like crystals of C, Si, Ge and Sn have been studied. The systems were strained in the range of +/−4%. The following characteristics have been evaluated as functions of the strain: Poison's ratios, elastic coefficients, band gaps in between chosen band structure points and band offsets. A detailed discussion of observed effects (considering also the orbital composition of bands) such as indirect direct gap transition, opening/closing the gaps, strain induced symmetry breaking effect and band offsets, the effect of lowering the band gap on electron mobility, will be presented.

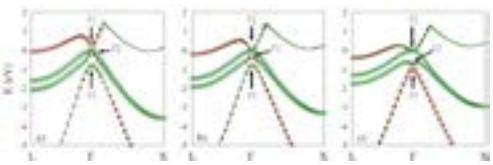

Figure: Sn under pressure showing characteristic features of electronic structure of group IV diamond like crystals

Recent Publications

1. Polak M P, Scharoch P and Kudrawiec R (2017) The electronic band structure of Ge1−x Sn x in the full composition range: indirect, direct, and inverted gaps regimes, band offsets, and the Burstein–Moss effect. Journal of Physics D: Applied Physics 50.19:195103.
2. Polak M P, Scharoch P and Kudrawiec R (2015) First-principles calculations of bismuth induced changes in the band structure of dilute Ga-V-Bi and In-V-Bi alloys: Chemical trends versus experimental data. Semiconductor Science and Technology 30(9):094001.
3. Kopaczek J, Polak M P, Scharoch P, Wu K, Chen B, Tongay S, et al. (2016) Direct optical transitions at K- and H-point of Brillouin zone in bulk MoS2, MoSe2, WS2, and WSe2. Journal of Applied Physics 119(23):235705.
4. Dybała F, Polak M P, Kopaczek J, Scharoch P, Wu K, Tongay S, et al. (2016) Pressure coefficients for direct optical transitions in MoS2, MoSe2, WS2, and WSe2 crystals and semiconductor to metal transitions. Scientific reports 6:26663.
5. Kudrawiec R, Kopaczek J, Polak M P, Scharoch P, Gladysiewicz M, Misiewicz J, et.al. (2014) Experimental and theoretical studies of band gap alignment in GaAs1-xBix/GaAs quantum wells. J Appl Phys; 116(23).

Biography

Norbert Janik is a PhD student at Theoretical Physics Department and has his expertise in ab initio calculations of strained systems.

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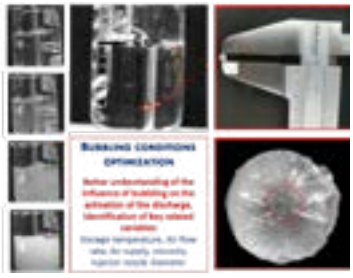
Marie Duquesne et al., J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

A promising biosourced, organic phase change material for seasonal storage

Marie Duquesne, Fouzia Achchaq and **Elena Palomo del Barrio**
Bordeaux INP, France

BioMCP aims to study bio sourced phase change materials for the thermal energy storage in buildings and heating networks. Thermal energy storage is one of the key elements to optimize the use of available energy resources (especially renewable ones) and to improve the energy efficiency of buildings. Phase change materials (PCMs) used for the thermal energy storage are an important class of materials which substantially contribute to the efficient use and conservation of waste heat and solar energy. In this framework, our objective is to develop and study new bio sourced phase change materials, able to compete with water as storage material and presenting improved performances in comparison with currently used PCM (ie: low cost, high energy density, low ecological impact). Among bio-based materials, Xylitol has a high potential as a thermal energy material. Its melting point is inferior to 95°C which allows combining the storage unit containing Xylitol with cheap solar collectors. Its latent heat is superior to 263 J.g-1 and its total energy density is 4-5 times higher than the one of water (110-150 kWh.m-3 whereas it is approximately 30 kWh.m-3 for water on a seasonal basis). Its high and stable undercooling allows long-term storage in a metastable state with reduced thermal losses and a negligible risk of spontaneous discharge. However, the activation of the energy discharge process (crystallization activation) is difficult and the subsequent crystallization rates (discharge powers) are very low. Our work in the framework of the FP7 EU SAM.SSA Project, coordinated by Elena Palomo Del Barrio, aims at finding out an easy to implement and efficient solution to discharge the storage unit at the required power when needed. This means being able to trigger nucleation at any time (or temperature) followed by a crystallization of the entire phase change material in due time. Different techniques to crystallize Xylitol have hence been considered. Finally, the feasibility of an innovative, efficient and low intrusive technique to activate the energy discharge is proven. Bubble agitation is a very promising technique. Our work focuses on providing a better understanding of the influence of bubbling on crystallization, on identifying key related variables and on paving the way for bubbling conditions optimization.



Recent Publications

1. Duquesne M, Palomo Del Barrio E and Godin A (2019) Nucleation triggering of highly undercooled xylitol using an air lift reactor for seasonal thermal energy storage. Applied Sciences 9(2): 267-277.
2. Godin A, Duquesne M, Palomo del Barrio E, Achchaq F and Monneyron P (2017) Bubble agitation as a new low intrusive method to crystallize glass-forming materials. Energy Procedia 139:352-357.

3. Zhang H, Duquesne M, Godin A, Niedermaier S, Palomo Del Barrio E, Nedea S V, Rindt C C M (2017) Experimental and in silico characterization of xylitol as seasonal heat storage material. Fluid Phase Equilibria 436:55-68.

Biography

Marie Duquesne defended her PhD "Resolution and reduction of a non-linear energy storage model by adsorption on zeolites" in 2013 at the University of Bordeaux. She is Associated Professor at the Institute of Technology of Bordeaux since 2015 and Researcher at TREFLE in Department Fluids and Transfers of I2M at the Institute of Mechanics and Engineering. She has expertise in thermal energy storage at low-to-medium temperatures. She contributed to the ANR Project SIMINTHEC in National Project from 2008 to 2011; European FP7 SAM.SSA Project from 2012 to 2015 and contributes to the Interreg SUDOE European SUDOKET Project from 2018 to 2021 and to the Region Nouvelle Aquitaine BioMCP project from 2018 to 2021. Her areas of research interest are Thermal energy storage; Phase change materials; Charge and discharge processes and imaging techniques.

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Notes:

Qiuhe Peng, J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

Explosion of collapsed supernova and hot big bang of the universe driven by magnetic monopoles

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Nanjing University, China

An anomaly of strong radial magnetic field near the galactic center (GC) is detected. The lower limit of the radial magnetic field at r = 0.12 pc from the GC. Its possible scientific significances are following: The black hole model at the GC is incorrect. The reason is that radiations observed from the region neighbour of the GC are hardly emitted by the gas of accretion disk due to which it is being prevented from approaching to the GC by the abnormally strong radial magnetic field. This is an anticipated signals for existence of magnetic monopoles (MM). The lower limit of the detected radial magnetic field is quantitatively in agreement with the prediction of our paper "An AGN Model with MM". Magnetic monopoles may play a key role in some very important astrophysical problems using the Robakov Callen effect that nucleons may decay catalyzed by MM. Taking the RC effect as an energy source, we have proposed a unified model for various supernova explosion including to solve the question of the energy source both in the earth core and in the white dwarfs. We may explain the physical reason of the hot big bang of the universe with the similar mechanism of supernova explosion by using the RC effect as an energy source.

Recent Publications

1. Eatough R P, et al., (2013) A strong magnetic field around the supermassive black hole at the centre of the Galaxy. Nature 591:391-393.
2. Qiu-He Peng, Jing-Jing Liu and Chi-Kang Chou (2016) A possible influence on standard model of quasars and active galactic nuclei in strong magnetic field. Astrophys Space Sci 361:388.

Biography

Qiuhe Peng is mainly engaged in nuclear astrophysics, particle astrophysics and Galactic Astronomy research. In the field of Nuclear Astrophysics, his research project involved a neutron star (pulsar), the supernova explosion mechanism and the thermonuclear reaction inside the star, the synthesis of heavy elements and interstellar radioactive element such as the origin of celestial 26Al. In addition, through his lectures, he establishes Nuclear Astrophysics research in China, He was invited by Peking University, by Tsinghua University (both in Beijing and in Taiwan) and by nuclear physics institutes in Beijing, Shanghai, Lanzhou to give lectures on Nuclear Astrophysics for many times.

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Notes:

Nasser Saad, J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

Heun equation and its uses in physics

Nasser Saad
University of Prince Edward Island, Canada

Most theoretical physicists are aware of the significant applications of the hypergeometric differential equation and it's impact was not only on Physics but also on many other areas of Science. The present talk answers the following simple question like under what conditions of the equation parameters do the differential equation. $p_n(x)\frac{d^n y}{dx^n} + p_{n-1}(x)\frac{d^{n-1} y}{dx^{n-1}} + p_{n-2}(x)y = 0$ Where, $p_j(x)$ is a polynomial of degree j, have polynomial solutions and if it does, can we construct them explicitly? The answer to this question will lead us to study the Heun equation (n=3), where we analyze the possible polynomial solutions and study some of their mathematical properties. Some applications, for example, the general deformed Hulthen potentials and Soft-core Coulomb potential will be investigated.

Recent Publications

1. G M Ismal, M Abul-Ez N M Farea and N Saad (2019) Analytical approximations to nonlinear oscillation of nanoelectro-mechanical resonators. The European Physical Journal Plus 134(1):47.
2. R L Hall, N Saad and K D Sen (2018) Exact normalized eigenfunctions for general deformed Hulthen potentials. Journal of Mathematical Physics 59.12:122103.
3. R L Hall, N Saad and Kyle R Bryenton (2018) The d-dimensional softcore Coulomb potential and the generalized confluent Heun equation. Journal of Mathematical Physics 59(10):102105.
4. K L A Kirk, Kyle R Bryenton, N Saad (2018) A note on the Generalized and Universal Associated Legendre equations. Communications in Theoretical Physics 70(1):019.
5. Ash Arsenault, Sheldon Opps and Nasser Saad (2016) Solvable potentials with exceptional orthogonal polynomials, Annalen der Physik 528(3-4):321-334.

Biography

Nasser Saad works in the area of special functions and their applications in Mathematical Physics. He is one of the founders of the Asymptotic Iteration Methods (AIM) that found many applications in all area of physics.

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Notes:

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Young Researchers Forum

D M Tibaduiza, J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

On the algebraic exact solution for the quantum harmonic oscillator with variable frequency

D M Tibaduiza
Institute of Physics-UFRJ, Brazil

In the last four decades the Harmonic Oscillator with Variable Frequency (HOVF) has drawn big attention as the principal model leading to squeezing states. We use algebraic methods to solve this problem for the first time in the Schrodinger picture. The solution is presented in a compact recursive form through general continuous fractions and enables calculate the final state of the system and the dynamics for any frequency function including such with jump discontinuities. In addition, we implement a numerical calculation of the solution and study the transition from a sudden change to adiabatic behavior between two frequencies.

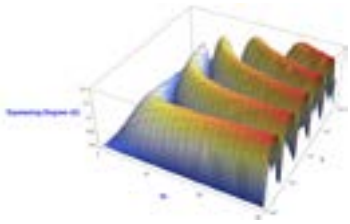

Figure: Tridimensional plot of the squeezing degree r(t), for a sudden change in the HOVF as a function of the jump η_0 and the time τ

Recent Publications

1. Ether D S et.al (2018) Double-layer force suppression between charged microspheres. Physical Review E. 97:022611.
2. Ether D S et.al (2015) Probing the casimir force with optical tweezers. Europhysics Letters 112(4):44001.

Biography

D M Tibaduiza has completed his MSc in Theoretical Physics with emphasis in Colloidal Stability and is a PhD candidate in physics at the Federal University of Rio de Janeiro (UFRJ). He is actually researching in Quantum Electrodynamics and the Dynamical Casimir Effect. He is an expert in mathematical methods applied in physics and it is a computational implementation. He has extensive experience in basic physics and mathematics education. He has two collaborations published in reputed journals and two researches that will be submitted soon.

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Notes:

Mamuna Anwar et al., J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

New technical concepts for velocity map imaging in a THz streak camera

Mamuna Anwar and **Markus Drescher**
University of Hamburg, Germany

In this dissertation the development of a novel type of streak camera enabling multi-dimensional electron spectroscopy implying energy, angular as well as time resolution is presented. The new setup is based on a velocity map imaging (\ac{VMI}) spectrometer in collinear geometry for electron spectroscopy and Terahertz streaking adding time resolution to the setup. A highly efficient detection scheme being operational at comparably bad vacuum conditions allows for highest target densities upto 3x10^{22}/m^{3} making the setup particularly suited for low photon flux laboratory sources. The detection efficiency is explicitly calculated. In the proof of principle experiment xenon 4d photoelectrons are streaked and the ionizing and streaking pulses are characterized.

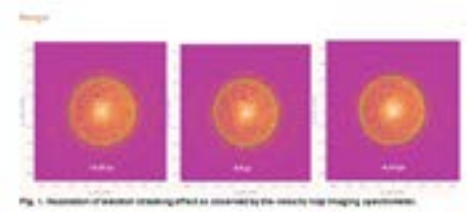

Figure 1: Illustration of electron streaking effect as observed by the velocity map imaging spectrometer

Biography

Mamuna Anwar has expertise in time resolved studies of Atomic and Molecular Physics. She got her Masters from University of Jena, Germany and PhD from University of Hamburg, Germany.

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Notes:

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Video Presentation

Valentyn A Nastasenko, J Astrophys Aerospace Technol 2019, Volume 7
DOI: 10.4172/2329-6542-C2-041

Refinement of law the world gravitation force for gravitational field of the universe

Valentyn A Nastasenko
Kherson State Maritime Academy, Ukraine

Currently, the force of gravitation is determined by the value F_G of interaction between the two point bodies of mass m_1, m_2 (kg) which is located at a distance r (m) between them, according to the law of world gravitation, who discovered Newton. Currently the law for the force of the gravitational field is discovered. He was received on the basis of found parameters of the gravitational field waves: the frequency $\nu_G = 7.4 \cdot 1042$ Hz, wavelength $\lambda_G = c/\nu_G = 4.051249|432| \cdot 10^{-35}$ m (where c– is speed of light in vacuum), energy of this wave $E_G = h\nu_G$ (where h – is the Plank's constant) and the mass equivalent of energy this wave $m_G = h\nu_G/c^2$. In this case $N = r/\lambda_G$ is the number of gravitational field wavelengths λ_G, which are placed on the vector of the distance r between the selected objects. The connected of

basic and new forces (where G – gravitational constant) is the form (1): $F_G = G\frac{m_1 m_2}{r^2} = G\frac{m_1 r m_G}{r^2 r^2} = G\frac{m_1 r m_G}{\lambda r^2 r^2} = G\frac{m_1 m_G}{\lambda r^2} = \frac{G m_G}{\lambda r^2} \times \frac{m_1}{r} = c^2 \times \frac{m_1}{r}(N).$ (1) from this dependence it follows that the force F_G of action the gravitational field on an object of mass m1, within the framework of the law $E = m_1c^2$, it is energy function. However, the speed of light c can be obtained through the frequency ν_G and wavelength λ_G gravitational field within the framework of the dependence: $c = \lambda_G \nu_G$. Based on the dependence c^2, this allows you to select the acceleration of free fall g_G of the universe, in the form of equality (2):

$c^2 = (\lambda_G \nu_G)^2 = (\lambda_G \nu_G^2)\lambda_G = g_G \lambda_G = 2.2184638 \cdot 10^{31}\left(\frac{m}{s^2}\right) \times \lambda_G(m).$ (2) Thus, the force F_G of the gravitational field is reduced to the inertial force (3):

$F_G = \frac{m_1}{r} g_G \lambda_G = \frac{m_1 g_G}{N}(N).$ (3) Within the framework of law (3), in order to exclude a gravitational collapse, all objects of the material world in the universe should rotate relative to the centre of mass.

Biography

Valentyn A Nastasenko is a Professor of Department of Transport Technologies of Kherson State Maritime Academy, Kherson, Ukraine. He is a candidate of technical sciences. The scope of his scientific interests includes quantum physics, gravitation theory and the foundations of the material world and the birth of the universe the author of more than 50 scientific papers in these fields.

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