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e-Poster Presentation

Ion I Cotaescu, J Astrophys Aerospace Technol 2018, Volume 6
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De sitter relativity in static charts

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The relative geodesic motion in static (and spherically symmetric) local charts on the (1+3)-dimensional de Sitter spacetimes is studied in terms of conserved quantities. The Lorentzian isometries are defined, relating the coordinates of the local chart of a fixed observer with the coordinates of a mobile chart considered as the rest frame of a massive particle freely moving on a time like geodesic. The simple relativistic effects are briefly presented pointing out some of their notable features in this geometry.

Biography

Ion I. Cotaescu is a retiring professor in theoretical physics of 75 years old. He is still Ph.D. advisor for theoretical physics at the West University of Timisoara where he was successively since 1972: assistant professor, lecturer, associate professor and professor. Between 1990 and 1996 he was the Dean of the Faculty of Physics. After 1996 he was Chairman and Director of the Center of Researches in Theoretical Physics until 2011 when he was retiring.

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A new approach for electron microprobe zircon fission track thermochronology

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Fission track thermochronology (FTT) has been applied for decades to quantify rates and timing of processes in the shallow crust. The most widely used approach is the external detector method (EDM). In this conventional approach, an age is obtained by counting both the fossil (^{238}U spontaneous fission) and the induced (^{235}U induced fission) tracks using an optical microscope. The induced tracks are obtained through the irradiation of the sample with thermal neutrons in the nuclear reactor, which causes fission of ^{235}U. Based on the studies carried out by Gombosi et al. (2014), we present an alternative method of dating zircons using electron probe microprobe analysis (EPMA) to measure uranium concentration [U]. The electron microprobe analysis fission track (EPMA-FT) method was applied to three samples of rapidly cooled zircons: the Fish Canyon Tuff, Poços de Caldas (syenite) and Serra Geral zircons. The analyses were performed using two approaches: 1) Using the age equation described in Gombosi et al. (2014) and 2) Using a new age equation calibration developed for this work. The results using the Gombosi et al. (2014) age equation were 26.7 ± 4.1 Ma, 80.6 ± 12.8 Ma and 130.9 ± 20.1 Ma, respectively and the results using the age equation from this work were 27.8 ± 1.9 Ma, 83.8 ± 7.7 Ma and 136 ± 12 Ma, respectively (figure 1). The uncertainty of the age is affected mainly by ^{238}U concentration and ρS (the spontaneous fission track density) determinations. Other factors can affect the uncertainty of the age, but their contributions are smaller. For all samples, the yield ages found by the two methods are consistent and overlap within two standard deviations of published reference ages determined from other radiometric techniques (i.e., K/Ar, 40Ar/39Ar and/or U/Pb) and traditional FTT by the EDM.

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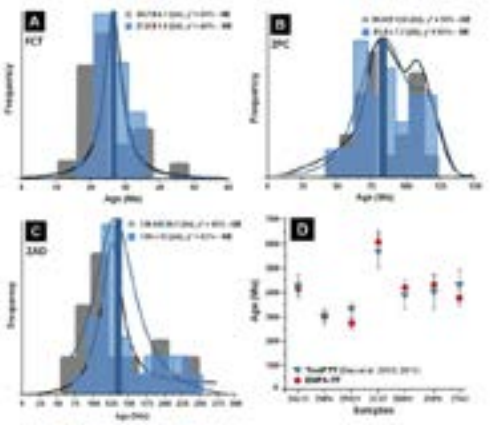

Figure 1. Histograms showing the age distribution of EPMA-FT single grain age determinations to FCT (A), ZPC (B) and ZAD (C) samples. Blue and gray lines denote the central age determination from the grain population. Blue and black lines show the probability density estimate. (D) Comparative analysis among ages obtained by Traditional FTT and EPMA-FT (Novel equation). GE means Gombosi's equation, and NE means Novel equation.

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Long term beam dynamics and ion kinetics in ultra-low energy storage rings

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Electrostatic storage rings operate at very low energies in the keV range and have proven to be invaluable tools for atomic and molecular physics. Because of the mass independence of electric rigidity, these machines are able to store a wide range of different particles, from light ions to heavy singly charged bio-molecules, opening up unique research opportunities. However, earlier measurements have shown strong limitations on beam intensity, fast growth of beam size and decay of ion current, reduced lifetime of ion beam. The nature of these effects has not been fully understood. Also a large variety of experiments in future generation ultra-low energy storage and decelerator facilities including in-ring collision studies with a reaction microscope require a clear understanding of the physical processes involved into the operation of such rings. Nonlinear and long-term beam dynamics studies in ultra-low energy storage rings are presented on the examples of a number of existing and planned electrostatic storage ring facilities. The results from simulations were benchmarked against experimental data of beam losses in the ELISA storage ring [S.P. Møller et al., Proceed of the European Particle Accelerator Conference, Vienna, 2000, pp. 788–790)]. It was shown [1,2,3] that decay of beam intensity is mainly caused by ion losses on ring aperture due to multiple scattering on residual gas. Beam is lost on electrostatic elements and collimators due to small ring acceptance. Rate of beam losses increases at high intensities because of the intra-beam scattering effect adds to vacuum losses. Detailed investigations into ion kinetics, under consideration of effects from electron cooling and multiple scattering of the beam on a supersonic gas jet target, were carried out and yields a consistent explanation of the physical effects in a whole class of ultra-low energy storage rings. The lifetime, equilibrium momentum spread and equilibrium lateral spread during collisions with the target are estimated. Based on computer simulations, the conditions for stable ring operation with an extremely low-emittance beam are predicted. Finally, results from studies into the interaction of ultra-low energy ions with a gas jet target are summarized.

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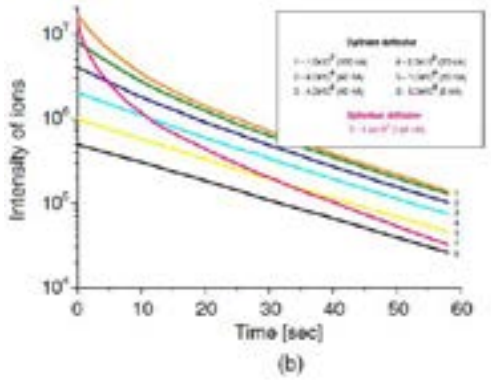

Figure 1: Computer simulations of O- ions decay in ELISA ring at 22 keV beam energy.

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New technique of thin silicon epitaxial detectors and application of it to nuclear physics and heavy ions

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Since thickness of silicon detectors made planar technology is limited to about 300 μm we have elaborated the new technology of thin detectors named "Low-temperature technique of thin silicon ion implanted epitaxial detectors". In this technique the photolithography, ion implantation and high-temperature anealing of planar technology is replaced by application mechanical mask followed by ion implantation, Al evaporation and long-time, low-temperature baking of prepared silicon detectors in the environmental atmosphere (A. J. Kordyasz *et al.*, Eur. Phys. J. **A51** (2015) 15). Using this technique the 5 μm thick strip eptaxial detectors have been produced (A. J. Kordyasz *et al.*, Acta Phys. Pol. **B47** (2016) 207). The detector strip widths of about 10 μm on 5 μm thick silicon epitaxial layer were achieved (A. J. Kordyasz *et al.*, HIL Annual Report 2016, page 77). In the proposed talk the "Low -temperature technique of thin silicon ion implanted epitaxial detectors" will be presented and new results of measurements will be shown. Future application to nuclear physics and heavy ions will be discussed.

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Does the postulate 'wave-particle duality' guide us to extract new knowledge out of nature?

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It is just below a century that the postulate, "wave-particle duality, was formalized to explain observed data in typical experiments involving double-slit diffraction or two-beam interferometers, mathematically expressed as the Superposition Principle (SP). The resultant amplitude $d(\tau)$ is given by:

(1) $$d(\tau) = a_1 e^{i2\pi f(t+\tau)} + a_2 e^{i2\pi ft}$$

Note that $\tau = (\tau_2 - \tau_1)$ (see top fig on right). $d(\tau)$, in Eq.1 in general, contains at least three variable parameters, depending upon the experimental conditions. Can a stable single elementary particle (photon or electron) carry all these variable parametric values? Further, linear superposition expression for SP in Eq.1 is not an observable! What is observable is the Superposition Effect, generated by a detector after it executes the nonlinear square modulus operation due to joint stimulation induced by the two field amplitudes:

(2) $$D(\tau) = \left| \chi a_1 r e^{i\pi} e^{i2\pi f(t+\tau)} + \chi a_2 e^{i2\pi ft} \right|^2$$

Here is the linear polarizability of the detector resonant to the intrinsic frequency of the photon or the particle.

The key point is that our mathematical expression Eq.1 for SP does not represent a single particle. SP is not observable. Therefore, we must not try to interpret observable SE of Eq.2 based upon Eq.1. Observables are generated through real physical *interaction processes* between some interactants. We make mistake by uncritically accepting that dark fringes in our superposition experiments are due to non-arrival of photons or particles. At the dark fringe locations, as per Eq.2, physically two out-of-phase oscillating fields are trying to stimulate the detecting particle. Therefore, it remains un-stimulated and hence cannot absorb any energy out of the two stimulating fields. These "out-of-phase" locations remain dark.

I will show videos of optical Mach-Zehnder interferometry to demonstrate that one needs the simultaneous presence of two signals on the opposite sides of the final beam combiner to generate observable superposition effects.

The top figure on the right underscores that we must have two signals arrive on a detector with two different phase –delays due to propagation, or path delays. The bottom figure on right illustrates the noticeable difference in the observable fringe contrast in double-slit experiments due to neutron particles (bottom left) and due to an optical beam. I will explain the causes. I will also extend the discussion to interpretation of Quantum of Mechanics.

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Interatomic potentials, atom energy and screening constants

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Simple formulae for estimating atom energy (the electron subsystem energy of atom) and screening constant have been proposed. The formula for the screening constant fits well experimental data on interaction potentials. Quantitative description of the experiment for the effect of electronic screening on the nuclear synthesis reaction cross-section for the D+/-D system has been obtained. A conclusion has been made that the differences between the measured cross-sections and their theoretically predicted values which take place in more complicated cases of nuclear synthesis reactions are not caused by uncertainties in the knowledge of interatomic potentials. The interatomic potential determines the nuclear stopping power in materials. Experimental data prove that the approach of determining interatomic potentials from quasielastic scattering can be successfully used. Experimental data on the scattering of atomic particles were analyzed and an analytical potential form was proposed as the best fit of the available experimental data. It is shown that Application of any universal potential is limited to internuclear distances R<7 af (af is the Firsov length).The paper discusses pair-specific interatomic potentials determined both experimentally and by density-functional theory simulations with the DMol approach to choosing basic wave functions. The interatomic potentials calculated using the DMol approach demonstrate an unexpectedly good agreement with experimental data. Differences are mainly observed for heavy atom systems, which suggests that they can be improved by extending the basis set and more accurately considering the relativistic effects. These data are recommended for modeling collision cascades in ion-solid collisions.New methods to obtain potential parameters from rainbow scattering features in the atom–metal surface collisions are discussed. Obtained results differ strongly from the known binary potential models. This difference is explained by the influence of interaction of the projectile with metal electrons. Observed patterns of black-body radiation.

Biography

Alexander Zinoviev has his expertise in atomic, plasma and nuclear physics. He completed his PhD at the age of 31 and later, in 1992, got the status of Dr Habil from Ioffe Institute in St. Petersburg. He has been selected as a head of the lab of atomic collision in solids. He is a coordinator of the Atomic Physics Research at Ioffe Institute.

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Generation and coherent proprieties of entangled bi-modal field and its application

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It is investigated the application of coherent emission of two subgroups of quanta obtained in the cooperative decay of excited enable of radiator (nuclei, atoms or molecules) mixture, so that correlation appears between the blocks of quanta belonging to different modes of the electromagnetic field. It is proposed the new effect, in which the two-quantum cooperative emission is established between the two sub-ensemble of excited radiators (see Fig. 1 A and B). The equidistant two-level sub-ensemble, excited relative the dipole forbidden transition, can be ignited in two-quantum super radiance regime by single-photon decay process of dipole active species of radiators. We chose the situation in which the one-photon Dicke cooperative emission is inhibited by large emission band of the dipole active sub-ensemble. In this situation the new three particle exchange integrals between the dipole forbidden and dipole active sub-ensembles drastically increases. So the cooperative emission of the dipole-forbidden sub-ensemble of atoms stimulates the two-quantum emission of dipole-active species of radiators. This cooperative process between the dipole-forbidden radiators and dipole-active sub-ensemble is accompanied by the establishment of the coherence between the photon pairs. The multi-mode broadband light can be reduced to the coherent states of the bimodal ensemble of the electromagnetic field. The method of recording of information from such a coherent field opens the new perspectives in stimulation gamma emission, quantum cryptography and quantum information. At the first glance, one observes that such coherent effects may have nothing new in comparison with the traditional one- photon coherence. But the two-quantum coherent beam may be destroyed or restored if the photon-pair pulses pass through a disperse medium. So the "idler" photons from each pair change their directions relative to "signal" photons. Focusing the "signal" and "idler" photons into different optical fibers, we can destroy the coherence among the bi-photons. However, after a certain propagation distance, the "idler" and "signal" photons from the pairs may be mixed again and we may observe, that the restoration of coherence propriety of the bimodal field.

Fig: A. The mutual cooperative effects in two-photon transitions between the dipole-active atoms S and R and dipole forbidden transition of D atoms; B. The similar mutual transitions between dipole active atoms D subsystem in scattering process

Biography

From 1981 to 1985 Nicolae A. Enaki was the post-graduate student of the radio-physics department, Physics Faculty of Lomonosov State University from Moscow. Here he was focused on the subject of PhD dissertation "Quantum Statistics of superradiance in an extended system of radiators". After that N Enachi continues the studies of the quantum statistical properties of radiation in "Single- and two-photon cooperative processes in optics" (the theme of Dr. Habilitatus dissertation, 1993). Scientific advisor of Quantum Optics and Kinetic Process Lab in Institute of Applied Physics, Chishinau, R. Moldova. As a professor in physics, his lessons are reflected in the monograph "Nonlinear Cooperative effects in open quantum systems: entanglement and second-order coherence", published in Nova Science Publishers, NY, USA, 2015, 325 pp, which of course reflects his research Interests. At this moment he is scientific advisor of two international grants: NATO SPS and STCU.

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J Astrophys Aerospace Technol 2018, Volume 6
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Liquid drop model of nuclei with account of viscosity

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In present the interest to nuclear matter hydrodynamics increases. Liquid drop model (LDM) successfully being used for semi-empirical formulation of surface and Coulomb terms in Bethe-Weizsacker mass formula. In this study in the frame of nuclear liquid drop model an analytical solution for the frequency of capillary oscillations is obtained with taking into account the damping due to viscosity and surrounding medium motion and polarizability. The normal coordinates for the drop capillary oscillations are coefficients a_l in expansion for drop surface radius over the Legendre polynomials

$$R(\mu) = \sum_{l=0}^{\infty} a_l P_l(\mu),$$

where $\mu=cos\theta$, θ is the polar angle shown in Fig.

The result for square of capillary oscillation frequency looking is as follows

$$\omega_l^2 = \frac{l}{a^3}\left(\frac{(l-1)(l+1)(l+2)\sigma}{\rho_1(l+1)+\rho_2 l} - \frac{3Z^2e^2}{4\pi a^3}\frac{(l+1)(l\varepsilon_1+(l-2)\varepsilon_2)}{(\rho_1(l+1)+\rho_2 l)(l\varepsilon_1+(l+1)\varepsilon_2)}\right) - \gamma_n^2$$

$$\gamma_n = \frac{(2l+1)\left((l-1)(l+1)\eta_1 + l(l+2)\eta_2\right)}{a^2\left((l+1)\rho_1 + l\rho_2\right)}$$

where a is nucleus radius, ρ_1, η_1 are the nuclear core matter density and viscosity, ρ_2, η_2 are the density and viscosity of surrounding area, ε_1 and ε_2 electrical permittivities of the inner and outer core medium, respectively. Comparison of octupole and quadrupole vibrations for empty exterior gives

$$\eta = \rho a^2\sqrt{\frac{15\omega_2^2 - 4\omega_3^2 + \frac{60E_0}{7Ma^2}}{734}},$$

where $E_0 = \frac{3}{5}\frac{Z^2e^2}{a}$.

The model with empty exterior has been applied for estimation of even-even spherical nuclei surface tension and viscosity. On the base of experimental data, it has been shown that energy shift of capillary oscillations of even-even spherical nuclei due to viscous dissipation gives viscosities in the interval 4.2–7.6 MeV fm−2 c−1 for nuclei from Pd–106 to Hg–198. For non-zero temperatures the ratio of shear viscosity η to entropy density s is estimated and compared with the limit $\frac{\eta}{s} > \frac{1}{4\pi}$ motivated by AdS/CFT for quark–gluon plasma.

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Encryption algorithms based on bio molecular information

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Nowadays, most of the applications using on the Internet are based on the idea that smart sensors can be embedded on a wide variety of objects and devices. New communication schemes are being deployed between these devices so as to develop pervasive computing and ambient intelligence contexts. Due to the security risks that are associated to these communication channels, new protection techniques are being investigated to cover the specific requirements of the future Internet. Cryptosystems based on molecular biology are among the most promising techniques to implement security policies on a large amount of data. This talk provides a review of the recent advances that have been made in the context of encryption using molecular biology information. These information have interesting properties including high-storage capacity, rapid parallelism, and energy-efficiency. One of the most important problems in this field is the Hamiltonian Path Problem which consists in determining the shortest path traversing each node of a directed graph exactly once and returning to the last node. The DNA molecule - as a carrier of data - has a large capacity. One trillion bits of binary data can be stored in one cubic decimeter of a DNA solution. DNA cryptography is built on DNA - which is an information carrier - and modern biotechnology for its tools, and it achieves the encryption process by the use of the characteristics of DNA of massive parallelism and high storage density. In addition, the reason why we can combine cryptography and molecular biology is the encoded plaintext, which can combine the computer and the use of molecular biological techniques, such as polymerase chain reactions, polymerization overlapping amplification, affinity chromatography, cloning, mutagenesis, molecular purification, electrophoresis, magnetic bead separation and other techniques of molecular biology, and then obtain the final cipher text. Most importantly, DNA code abandons that traditional cryptography which uses the intractable mathematical problem of the security guarantee, instead using the limited nature of the learning of biology.

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Quantum electrodynamics processes in the interaction of high-energy particles with atoms

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The recently developed method of employing quasiclassical Green's functions in solving the Dirac equation for various external field configurations has provided a breakthrough insight into the fundamental quantum electrodynamics processes whereby high-energy particles interact with atoms. I review recent results, exact in the atomic field parameters, on the cross sections for the electron-positron high-energy photoproduction, the single bremsstrahlung cross section for relativistic electrons and muons in the atomic field, double bremsstrahlung cross sections, electroproduction of bound and unbound pair. In many cases, the calculations are performed in the quasiclassical approximation with the inclusion of the first-order quasiclassical correction.

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Non-parametric method for testing an exponential sample for purity under condition of small statistics

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In many innovative physical experiments such as, e.g., the synthesis of super heavy elements the statistics of the observed data is small and there is not enough of the a priori information about the parameters of their distribution function. In such a situation the first step of the analysis - answering the question: is the observed data a decay of a single source or a mixture of sources including the background and the noise, requires use of methods little sensitive to the volume of the data analyzed and the a priori information about the parameters. The paper proposes such a non-parametric method: testing the ratio of the sample median and the sample mean.

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Where and why quantum mechanics ceases to work in molecular and chemical physics

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Let's turn to the basics of quantum mechanics. In atoms, the nucleus is essentially only a source of a potential electric field in which electrons move. Quantum mechanics works here: we write a Hamiltonian for electrons in this field and solve the corresponding Schrödinger equation. In molecules in a stationary state, where the adiabatic approximation works, on the contrary, electrons are considered as a source of a potential electric field in which the nuclei vibrate.1 Here quantum mechanics also works, but the price of this is the adiabatic approximation. Note that both in the former and in the latter cases, in essence one of the subsystems is "switched off" dynamically: in the case of atoms the nucleus is "turned off", and in the case of molecules the electrons are "turned off". Quantum mechanics works in molecules only until the electrons are dynamically "off". As soon as we begin to consider molecular quantum transitions, we are forced to treat electrons dynamically, that is, for transitions we already have two essential dynamical systems: nuclei that oscillate, and electrons whose charge distribution changes during the transition. And both systems strongly (through the Coulomb field) interact with each other. The whole "trouble" is that the mass of the electron is a colossal number of times smaller than the mass of the nuclei. In molecules, in their essential dynamics, when there is a structural reorganization of the nuclear subsystem in molecular quantum transitions, this fact leads to a singularity in the probabilities (per unit time) of quantum transitions. This singularity means that the joint motion of electrons and nuclei, when both subsystems are dynamically full-fledged,2 can not be regular. Therefore, this singularity must be damped by introducing chaos (dozy chaos) into dynamics of molecular quantum transitions or elementary chemical reactions, which is done by the author. But after the damping procedure is introduced, the whole theory ceased to be quantum mechanics: because of chaos in the intermediate dynamic state, we have a continuous spectrum of energy in this state, which is a sign of classical mechanics. Shortly speaking, the physical nature of molecular quantum transitions is associated with a certain, recently discovered, unique property of an electron that binds atoms to molecules. This property consists in provoking by a light electron of chaos in the vibrational motion of very heavy nuclei "for the purpose" to control their motion in the processes of molecular quantum transitions. Thus, an electron being a quantum micro-particle in an atom, which performs quantum jumps, in a molecule in the processes of molecular quantum transitions, it acquires the features of a classical motion. In the formal language, the situation is as follows. As is known, the theory of quantum transitions in quantum mechanics is based on the convergence of a series of time-dependent perturbation theory. In atomic and nuclear physics, the quantum-mechanical series of time-dependent perturbation theory converges because in the corresponding matrix elements of the transitions due to quantum jumps the dynamics of quantum transitions is absent by definition. On the contrary, this series diverges in molecular and chemical physics, since in these matrix elements the dynamics of "quantum" transitions, which is determined by the joint motion of a light electron (or electrons) and very heavy nuclei, is already present by definition. Strictly speaking, only two methods can eliminate the singularity in the quantum-mechanical series of time-dependent perturbation theory. The first method was proposed almost 100 years ago and consisted essentially in refusing to consider the dynamics of molecular "quantum" transitions by introducing an additional postulate in the form of the Franck-Condon principle into molecular quantum mechanics, in which the adiabatic approximation is used. The second method was proposed by the author and consists in replacing the infinitely small imaginary additive in the energy denominator of the total Green's function of the molecular system by its finite value. It follows from a comparison of the new theory with experiment that the modulus of this imaginary additive is much larger than the quantum of vibrations of the nuclei. This means that in the process of quantum transitions there is an exchange of motion and energy between the electron and the nuclei, and this exchange is so intense that chaos arises in the transient state. This chaos is called dozy chaos, since it is not present either in the initial or final states, and it arises only during molecular quantum transitions. The effectiveness of the damping procedure for the above singularity is demonstrated by the example of a new (dozy-chaos) theory of elementary electron-charge transfers in condensed media and its applications to the optical band shapes in polymethine dyes and their aggregates.

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Density matrix in description of the collision of atomic particle with solid film

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In a number of current investigations within the scope of modern physics the time-resolved experiments and consequence theories play a central role in understanding of physical phenomena. As an important example consider the detailed information about the particle-solid and particle- nucleus interaction physics. As an example of such a situation emphasize the next results:

1. The collision with solid leads to a significant decrease in the total coherence length of projectile's wave field. The coherence length can become much smaller than the initial size of wave field of projectile.

2. During the collision with solid the number of different spatial areas where the mutual coherence in the projectile's wave field is supported, can be multiplied.

3. The every part of projectile's wave field can be individualizing as the separate particle having own property in its inner quantum state. The procedure which has a responsibility for such a transformation can be characterized as a spontaneous breaking of symmetry.

4. The process described in the point 3 can be considered as a special form of breaking in quantum mechanics which can in principal explain a mechanism of nuclear breaking.

As an example consider the particle-atomic chain interaction phenomenon. Consider the passage of hydrogen atom parallel to the chain of seven carbon atoms (see figure). We observe a splitting the electron's wave packet during the passage. When the coherence length becomes less the interatomic distance we come to conclusion that among several points of electron localization must survive only one. How we can understand the detailed mechanism of such a transition? That problems tightly connected to famous wave function reduction problem and in principal can be solved with the help of estimating the time-evolution of density matrix.

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Computing continuum quaternionic wave functions for hydrogen

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Over the past few years considerable attention has been paid to the role of the Hydrogen Continuum Wave Functions (HCWFs) in quantum theory. The HCWFs and their applications to electron-atom collisions, cold atom physics and atomic ionization in strong laser elds played a key role in this development. The HCWFs arise via the method of separation of variables for the time-independent Schrodinger equation in spherical coordinates. The HCWFs are composed of products of a radial part involving associated Laguerre polynomials multiplied by exponential factors and an angular part that is the spherical harmonics. In this talk, we extend the continuum wave functions for hydrogen to Quaternionic Analysis (QHCWFs). In particular, the underlying functions are of three real variables and take values in the quaternion algebra. We prove that the QHCWFs are orthonormal to one another. The representation of these functions in terms of the HCWFs are explicitly given, from which several recurrence formulae for fast computer implementations can be derived. A summary of their fundamental properties and further computation of the hydrogen-like atom transforms of the QHCWFs are also discussed.

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Absolute pressure standard using cold atoms

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Particle detection in high and ultra-high vacuum environments below 10^{-6} torr is essential for beam flux measurements and ambient pressure determinations. Electron impact ionization and subsequent detection of the ions is, at present, the most widespread and sensitive method and it constitutes the functional basis for ionization vacuum gauges. These gauges suffer from the limitation that they lose their calibration when the ion production or collection efficiencies change because the sensor electrodes change position and the internal electric fields are altered or when the gain of the ion current multiplier is modified due to surface contamination or degradation. By contrast, a stationary or slowly moving atom, such as can be prepared by laser cooling, is an ideal particle flux sensor. In brief, the passage of a particle through the collision cross section of the sensor atom is detected by the momentum transferred to the quasi-stationary sensor atom. The incident particle flux is determined from the measured single-particle collision rate divided by the total cross section. The latter quantity can be computed from knowledge of the interaction potentials and the former is a measurement of time. The main advantage of this detection mechanism is that it is not subject to sensor degradation or calibration drift since the sensor atoms are always the same and the interaction between the sensor atom and the detected particle is an immutable law of nature. These features and the direct link between particle flux and time makes this method a unique candidate for the realization of a primary pressure standard at and below 10^{-6} torr.

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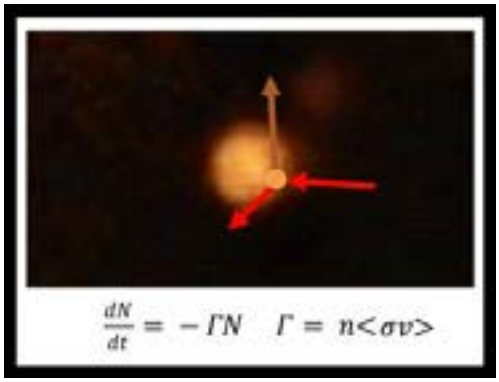

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Erosion and impurity deposition on diagnostic installations in a fusion reactor

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By reaching the vessel wall of a fusion reactor, charged plasma particles, electrons and ions, are recombined into neutral molecules and atoms of hydrogen isotopes. These species recycle back into the plasma volume and participate, in particular, in charge-exchange *(cx)* collisions with ions. As a result hot atoms with chaotically directed velocities are generated. Some of these flee into opening in the vessel wall for ducts guiding to diagnostic installations e.g., first mirrors for optical observations. Consequently, the mirror surface is destroyed. Besides, cx-atoms erode the walls both of the reactor vessel and of the diagnostic duct. The impurity particles released may migrate to the mirror surface and be deposited there. Both erosion and impurity deposition decline the reflectivity of mirrors. A theoretical model for processes outlined above is formulated, including a two-dimensional kinetic description of relevant neutral species in the vicinity of the duct opening in the vessel, an assessment of the erosion intensity of the vessel and duct walls and mirror surface by hot atoms, estimates for influxes of the vessel armor material into the duct and a consideration of the migration of impurity atoms along the duct towards the mirror surface. Calculations for the conditions predicted for a fusion reactor like DEMO are done and the erosion of and impurity deposition rates on first mirrors of Mo are assessed versus such input parameters as the duct radius, the distance from the opening to the mirror, the density ng of the working gas in the duct, the probabilities for impurity sticking to the duct wall and mirror surface. It is demonstrated that by increasing ng up to a level of $2*10^{19}m^{-3}$ one can reduce the mirror sputtering to the target level of 1nm per full power year or all input parameters considered the erosion rate of impurities deposited at the mirror significantly exceeds the deposition rate. Thus, no formation of impurity precipitations on the mirror surface has to be expected.

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Astronomical observational evidences of magnetic monopoles and its implication of astrophysics

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An anomaly 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 is $B \geq bmG$.

Its possible scientific significances are following:

1. **The black hole model at the GC is incorrect.** The reason is that radiations observed from the region neighbor of the GC are hardly emitted by the gas of accretion disk due to it being prevented from approaching to the GC by the abnormally strong radial magnetic field.
2. **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".
3. 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.**
4. **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.

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Holographic superconductors with nonlinear Born - Infeld-type electrodynamics

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Holographic s-wave superconductors in the framework of nonlinear Born-Infeld-type electrodynamics is investigated in the background of Schwarzschild anti-de Sitter black holes. As particular cases, at some model parameters, we obtain results for Born-Infeld and exponential electrodynamics. We explore the analytical Sturm-Liouville eigenvalue problem in the probe limit where the scalar and electromagnetic fields do not effect on the background metric. The critical temperatures of phase transitions and order parameters are calculated which depend on the model parameter. We show that the critical exponent near the critical temperature is 1/2.

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Helical modes generate anti-magnetic rotational spectra in nuclei

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A systematic analysis of the anti-magnetic rotation band using r-helicity formalism is carried out for the first time. The observed octupole correlation in a nucleus is likely to play a role in establishing the anti-magnetic spectrum. Such octupole correlations are explained within the helical orbits. In a rotating eld, two identical fermions (generally protons) with paired spins generate these helical orbits in such a way that its positive (i.e., up) spin along the axis of quantization refers to one helicity (right-handedness) while negative (down) spin along the same quantization-axis decides another helicity (left-handedness). Since the helicity remains invariant under rotation, therefore the quantum state of a fermion is represented by definite angular momentum and helicity. These helicity represented states support a pear-shaped structure of a rotating system having z-axis as the symmetry-axis. A combined operation of parity, time-reversal and signature symmetries ensures an absence of one of the signature partner band from the observed anti-magnetic spectrum. This formalism has also been tested for the recently observed negative parity DeltaI=2 anti-magnetic spectrum in odd-A ^{101}P d nucleus and explains nicely its energy spectrum as well as the B(E2)-values. Further, this formalism is found to be fully consistent with twin-shears mechanism popularly known for such type of rotational bands. It also provides signi cant clue for extending these experiments in various mass regions spread over the nuclear chart.

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