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Vyacheslav I Dokuchaev, J Astrophys Aerospace Technol 2016, 4:3(Suppl)
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Spin and mass of the nearest supermassive black hole

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A new method for exact determination of the masses and spins of accreting black holes from the observations of quasi-periodic oscillations is described. The detected signal from the hot spots in the accretion plasma must contain modulations with two characteristic frequencies: the frequency of rotation of the black hole event horizon and the frequency of the latitudinal precession of the spot orbits at the most bright inner edge of the accretion disk. The weak accretion activity of the dormant quasar Sgr A* at the galactic center occasionally shows up as quasi periodic X-rays and near-IR oscillations with the mean periods of 11 and 19 min. These oscillations can be interpreted as related to the rotation frequency of the Sgr A* event horizon and to the latitude oscillations of hot plasma spots in the accretion disk. Both these frequencies depend only on the black hole gravitational field and not on the accretion model. Using this interpretation it yields the most exact values for both the mass M and the spin a (Kerr rotation parameter) of the Sgr A*: $M=(4.2\pm0.2)10^6M_\odot$ and $a=0.65\pm0.05$.

Biography

Vyacheslav I Dokuchaev has completed his PhD from Moscow Institute of Physics and Technology and Post-doctoral studies from Lebedev Physical Institute at Moscow. He is the Leading Researcher at the Institute for Nuclear Research of the Russian Academy of Sciences. He has published more than 150 papers in reputed journals.

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One-loop effects of SUSY on the third generation fermion-pair and the Zh production at ILC

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Within the framework of the minimal supersymmetric standard model, we investigate one-loop effects of the supersymmetric particles on the fermion-pair production in the third generation and Zh in the ILC energy region. Three sets of the SUSY parameters are proposed which are consistent with the observed Higgs mass, the muon g-2, the Dark Matter abundance, etc. We discuss on the possibility of discovering the signals consistent with SUSY as well as of experimentally distinguishing the proposed sets of SUSY parameters. Minimal Supersymmetric Standard Model (MSSM) naturally explains: (1) The elementary Higgs with mh=125GeV, (2) WIMP dark matter with relic abundance ~ 0.1. In addition, we consider other constraints on the MSSM parameters from (3) muon g-2, (4) B-physics, (5) SUSY searches @ LHC and (6) WIMP searches, where we use "SuSpect2", "MicrOMEGAs" and "SUSY-HIT". Two typical parameter sets, which are consistent with (1)~(6) constraints, are selected. For the two sets, we investigate one-loop effects of the particles in the pair production of third generation fermions and the Zh production at the ILC, where we use "GRACE". The virtual effects of MSSM in the processes could become (1~5)% at the early stage of the ILC. Discrimination of the light and heavy stop scenarios would be possible in top pair and Zh.

Biography

Tadashi Kon has completed his PhD from Rikkyo University and Postdoctoral studies from Tokyo Metropolitan University. He is the Professor of Seikei University, Faculty of Science and Technology.

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Proposals for experimental verification of the origin of the cosmological red-shift

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We have two conflicting hypothesis about the origin of the cosmological red-shift. Hypothesis A: The red-sift is caused by the relativistic Doppler effect due to the expansion of the Universe (Hubble law). Hypothesis B: The red-shift is caused by the lost of energy of photons during the travel from the source to the observer (Bellert's law). The paper presents propositions of experimental validation of B. Proposition No.1, is based on the paper: S L Hahn, Possible experimental verification of Bellert's red-shift law using the Cosmic Background Radiation, Astrophysics and Space Science, vol.345, No.2, 2013, pp.363-366. Satellite missions confirmed that MBR is isotropic and has Planck spectrum of temperature 2.725 K. However, assuming the validity of Bellert's red shift law, it was shown that the temperature 2.725 K corresponds to a summation of radiations of a temperature about 3.5 K reaching the observer from all directions of the observable Universe. In a project submitted to ESO (code 2013.1.00936T, date 2013-12-05, not accepted) the author proposed to verify the hypothesis B using radio-astronomy observations of the dark Moon. The Moon is not transparent for mm wave MBR. Therefore, if an antenna located at Earth would detect in the cone defined by a point on Earth and the circle of Moon's radius, a radiation of temperature 3.5 K, the Bellert's law would be confirmed. Note that the dark Moon has a temperature of about 160 K. Therefore, the eventual detection of a radiation of 3.5 K would be possible only by application of statistical methods. Proposition N.2: A signal generated by a highly stable laser frequency standard should be transmitted in vacuum along a large distance d and compared at the receiver site by a second frequency standard to obtain a beat frequency. For a distance from Earth to a geostationary satellite, the beat period equals about two hours and for a distance from Earth to the Moon equals few minutes. The above experiments require the application of two laser frequency standards. Another possibility is to use the existing LIGO arrangement (Large Interferometer Gravitational Observatory). The laser beam in a vacuum tube 4000 m long is circulating 100 times. This corresponds to a value of d = 8000x100=800000 m =800 km, i.e. much less as the distance to the geostationary satellite. However, since the measurements can be repeated many times, there may be a chance to detect a very long beat period. In the case of LIGO, no second frequency standard is required.

Biography

Stefan L Hahn is a Retired Professor of the Warsaw University of Technology since 1981 and a Full Member of the Polish Academy of Sciences and a Life Senior Member of IEEE. He is the author of several papers printed in USA, Poland and Germany. He is the author of the book, "*Hilbert Transforms in Signal Processing*" (ArtechHouse 1986) and the coauthor of the book, "*Complex and Hypercomplex Analytic Signals: Theory and Applications*" (ArtechHouse 2016). He is the author of the extension of Gabor's analytic signals to higher dimensions (Proc. IEEE, 1992). He is also the author of a paper about the origin of gravitation (jmp.2015.68117).

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Quasars and the Gaia preliminary first data release

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The Gaia preliminary first data release (GDR1) is scheduled for the forthcoming September 16th, once complied the internal data validation. It will bring positions and G magnitudes, and the respective errors, for about 90% of the sky observable by Gaia. In addition a full astrometric solution will be given for the Tycho2 stars. As much as, it still is far away from the end-of-mission Galactic census, by a comparable much the GDR1 will be ahead away from the astrometric catalogues existing at the time of its release. In particular, we will detail the use of QSOs from the Gaia initial QSO catalogue (GIQC) to establish the celestial reference frame for the GDR1, and to set up the zero-point enabling to disentangle parallaxes from proper motions in the Gaia-Tycho2 full solution. Tied to this the GIQC is reviewed, with emphasis on its sky distribution, and the quality assessment, morphology and variability flags. Finally, an ongoing investigation on the proprieties of the QSOs spectral energy distribution (SED) is presented, including a new algorithm for the determination of absolute magnitudes. It is derived from the Gaia spectral library and it is thus important to interpret the QSOs luminosity function from the more than half a million QSOs that Gaia is expected to detect.

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Gravitational radiation by point particle eccentric binary systems in the linearized characteristic formulation of general relativity

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We have studied a binary system composed of point particles of unequal masses in eccentric orbits in the linear regime of the characteristic formulation of general relativity, generalizing a previous study found in the literature in which a system of equal masses in circular orbits were considered. We also showed that the boundary conditions on the time-like world tubes generated by the orbits of the particles can be extended beyond circular orbits. Concerning the power lost by the emission of gravitational waves, it was directly obtained from the Bondi's news function. It is worth stressing that our results are completely consistent, because we obtained the same result for the power derived by Peters and Mathews, in a different approach, in their seminal paper of 1963. In addition, the present study constitutes a powerful tool to construct extraction schemes in the characteristic formalism to obtain the gravitational radiation produced by binary systems during the inspiralling phase.

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Geomagnetically induced currents in Brazil over the solar cycles 23 and 24

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Geomagnetically induced currents (GIC) are a space weather effect, which affects ground-based technological structures at all latitudes on the Earth's surface. GIC occurrence and amplitudes have been monitored in power grids located at high and middle latitudes since 1970s and 1980s, respectively. This monitoring provides information about the GIC intensity and the frequency of occurrence during geomagnetic storms. In this work, we investigate GIC occurrence in a power network at central Brazilian region during the solar cycles 23 and 24. Calculated and measured GIC data, and are compared for the most intense and moderate geomagnetic storms (i.e., -150 < Dst < -50 nT) of the solar cycle 24. The results obtained from this comparison show a good agreement. The success of the model employed for the calculation of GIC led to the possibility to determine GIC for events during the solar cycle 23 as well. Calculated GIC reached ca. 30 A during the "Halloween storm" in 2003 whilst most frequent intensities lie below 10 A. The normalized inverse cumulative frequency for GIC data was calculated for the solar cycle 23 in order to perform a statistical analysis. It was found that a q-exponential Tsallis distribution fits the calculated GIC frequency distribution for more than 99% of the data. This analysis provides an overview of the long term GIC monitoring at low latitudes and suggests new insight into critical phenomena involved in the GIC generation.

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An econometric investigation of the sunspot number record since the year 1700 and its prediction into the 22nd century

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Solar activity, as measured by the yearly revisited time series of sunspot numbers (SSN) for the period 1700-2014 (Clette et al., 2014), undergoes a triple statistical and econometric checkup in this paper. The conclusions are that the SSN sequence: (1) is best modeled as a signal that features nonlinearity in mean and variance, long memory, mean reversion, 'threshold' symmetry, and stationarity; (2) is best described as a discrete damped harmonic oscillator which linearly approximates the flux-transport dynamo model; (3) its prediction well into the 22nd century testifies of a substantial fall of the SSN centered around the year 2030. In addition, the first and last Gleissberg cycles show almost the same peak number and height during the period considered, yet the former slightly prevails when measured by means of the estimated smoother. All of these conclusions are achieved by making use of modern tools developed in the field of financial econometrics and of two new proposed procedures for signal smoothing and prediction.

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Removing dust impact for visual navigation in Mars landing

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Visual navigation has received more and more attention in Mars landing. However, dust devils are active on Mars. The dust will make a great influence on visual navigation during the landing phase. So we proposed a simple but effective approach to remove the dust impact for visual navigation in Mars landing. This method was based on a model which was widely used to describe the scene radiance that was affected by different weather conditions. First the calculation method of transmission parameter was deduced from this model. Then the value of the global atmospheric light was estimated through the detection of most dust-opaque region. After all unknown variables were determined; the clear image was recovered by the corresponding formula and calculation method. For it was difficult to obtain the decent images that appear while the Mars rover enters the landing phase, a simulated dust environment was created in the lab and some images affected by dust were obtained to check the validity of this method. From the results of the experiments, the proposed approach can effectively eliminate the dust influences and provide clearer pictures. The clear images help to provide more precise data for visual navigation.

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Implications of the study of galaxy clusters and cosmic large-scale structure on neutrino masses and dark matter

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Galaxy clusters are sensitive probes of the large-scale structure of the matter density distribution of the Universe and they allow to obtain observational constraints of the masses if neutrinos. X-ray observations provide currently the best means to detect and characterize galaxy clusters. Using a statistically complete sample of galaxy clusters detected in the ROSAT All-Sky X-ray survey, we constrain cosmological parameters, specifically the matter density and the amplitude of the large-scale matter density fluctuations. A comparison of these results with the measurements of cosmic microwave background anisotropies with the Planck satellite show some tension, which implies less pronounced fluctuation amplitude of nearby large-scale structure as compared to the predictions based on Planck and a pure LCDM model. Damping of fluctuations by neutrino dark matter provides a plausible explanation for this discrepancy. We discuss the constraints on the neutrino mass from these findings and from other measurements of the nearby large-scale structure of the Universe.

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Diphoton Higgs decay in an U(1)′ model

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At present, the possible confirmation by the LHC of a scalar particle identified as the Higgs boson has increased the study of its different decay channels, where the diphoton decay is one of the most prominent processes, because of the excess reported by LHC. These excesses may be associated with new symmetries in models beyond the standard model. In particular, family non-universal U(1)' symmetry models have many motivations to be considered, because they involve a large number of phenomenological consequences and theoretical aspects as flavor physics, physics of neutrinos, dark matter, among other effects. These models also involve a new neutral boson Z', something else new anomalies appear. It is necessary to extend of the fermionic spectrum in order to obtain a chiral theory free of anomalies. On the other hand, the new symmetries require extended scalar sectors to generate the spontaneous breaking of the new Abelian symmetry and to get masses for the new gauge boson Z' and the extra fermionic content. In particular, the scalar sector is extended with two scalar doublets and two singlets, where one of the singlets is postulated as a dark matter (DM) candidate. The purpose of this work is to calculate the new contribution to the diphoton channel decay width of the Higgs, as it offers a clear signal of new physics associated with the scalar sector, where loop contribution from charged Higgs bosons are taken into account. Also, since the signal strength depends on the ratio with the total of Higgs boson decay, it is possible to evaluate the effects of a light DM component as an invisible final state.

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Measurements with diverse concepts in quantum/particle physics

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Much of particle physics uses data from new measurements, average measured properties of gauge bosons, leptons, quarks, mesons and baryons; there are many that are new or heavily revised including those on quark-mixing matrix, top quark, muon anomalous magnetic moment, extra dimensions, particle detectors, cosmic background radiation, dark matter, cosmological parameters and big bang cosmology. The model is based on gauge theories, of which the first was quantum electrodynamics, describing the interactions of light with matter. The core element of particle physics analysis as the name suggests is the physical characteristics that form the basis of the measurement. Decoherence theorists, who use various non-standard interpretations of quantum mechanics that deny the projection postulate quantum jumps and even the existence of particles, define the measurement problem as the failure to observe superpositions such as Schrödinger's cat. Measurements are described with diverse concepts in quantum physics such as; wave functions/probability amplitudes, evolving unitary and deterministic/preserving information, according to the linear Schrödinger equation, superposition of states, i.e., linear combinations of wave functions with complex coefficients that carry phase information and produce interference effects/the principle of superposition, quantum jumps between states accompanied by the "collapse" of the wave function that can destroy or create information, probabilities of collapses and jumps given by the square of the absolute value of the wave function for a given state, values for possible measurements given by the eigenvalues associated with the eigenstates of the combined measuring apparatus and measured system. The expected consequence of Niels Bohr's "Copenhagen interpretation" of quantum mechanics, was to explain how our measuring instruments, which are mostly macroscopic objects and treatable with classical physics, can give us information about the microscopic world of atoms and subatomic particles like electrons and photons. Some define the problem of measurement simply as the logical contradiction between two laws describing the motion of quantum systems; the unitary, continuous, and deterministic time evolution of the Schrödinger equation versus the non-unitary, discontinuous, and indeterministic collapse of the wave function. Here, I intend to present a unified dynamics framework using particles connected by constraints as the fundamental infrastructure that let us treat measurements in a unified manner.

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Astronomical redshifts of highly ionized regions

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Astronomical or cosmological redshifts are an observable property of extragalactic objects and have historically been wholly attributed to the recessional velocity of that object. The question of other, or intrinsic, components of the redshift has been highly controversial since it was first proposed. This paper investigates one theoretical source of intrinsic redshift that has been identified. The highly ionized regions of active galactic nuclei (AGN) and quasi-stellar objects (QSO) are, by definition, plasmas. All plasmas have electromagnetic scattering characteristics that could contribute to the observed redshift. To investigate this possibility, one region of a generalized AGN was selected, the so called broad line region (BLR). Even though unresolvable with current instrumentation, physical estimates of this region have been published for years in the astronomical literature. These data, selected and then averaged, are used to construct an overall model that is consistent with the published data to within an order of magnitude. The model is then subjected to a theoretical scattering investigation. The results suggest that intrinsic redshifts, derivable from the characteristics of the ambient plasma, may indeed contribute to the overall observed redshift of these objects.

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Mg II lines observed during the X-class flare on 29 March 2014 by the interface region imaging spectrograph

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Mg II lines represent one of the strongest emissions from the chromospheric plasma during solar flares. In this article, we studied the Mg II lines observed during the X1 flare on 29 March 2014 by the interface region imaging spectrograph (IRIS). IRIS detected large intensity enhancements of the Mg II h and k lines, subordinate triplet lines, and several other metallic lines at the flare footpoints during this flare. We have used the advantage of the slit-scanning mode (rastering) of IRIS and performed, for the first time, a detailed analysis of spatial and temporal variations of the spectra. Moreover, we were also able to identify positions of strongest hard X-ray (HXR) emissions using the Reuven Ramaty high energy solar spectroscopic imager (RHESSI) observations and to correlate them with the spatial and temporal evolution of IRIS Mg II spectra. The light curves of the Mg II lines increase and peak contemporarily with the HXR emissions but decay more gradually. There are large red asymmetries in the Mg II h and k lines after the flare peak. We have seen two spatially well-separated groups of Mg II line profiles, non-reversed and reversed. In some cases, the Mg II footpoints with reversed profiles are correlated with HXR sources. We have showed the spatial and temporal behavior of several other line parameters (line metrics) and briefly discuss them. Finally, we have synthesized the Mg II k line using our non-LTE code with the multilevel accelerated lambda iteration (MALI) technique. Two kinds of models are considered, the flare model F2 of Machado et al., and the models of Ricchiazzi and Canfield. Model F2 reproduces the peak intensity of the non-reversed Mg II k profile at flare maximum, but does not account for high wing intensities. On the other hand, the RC model shows the sensitivity of Mg II line intensities to various electron-beam parameters. Our simulations also showed that the micro-turbulence produces a broader line core, while the intense line wings are caused by an enhanced line source function.

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Recurrent analysis of the large scale structures in non-uniform magnetospheric flows

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Near Earth space (ionosphere, magnetosphere) is characterized by complicated dynamics and for modeling of such processes, especially at conditions of external non-stationary impact (bow shock), it is very important for estimation of determined and stochastic parts of the dynamics, as well as the possibility of the generation of large scale wave and fractal structures. In this work, a physical model of the plasma perturbations for experimental data treatment and their physical and theoretical interpretation is obtained. In this model, a nonlinear mechanism of interaction of the perturbations with spatially inhomogeneous space flows is considered. Numerical simulation of formation of such large scale flows are carried out. Time series of velocity flow and magnetic field components of the magnetospheric flows observed by THEMIS satellite mission are studied by virtue of nonlinear methods. For numerical treatment of these data a recurrent diagram method is used, which is effective for short data series. Recurrence is a fundamental feature of the dissipative dynamical systems, which is used for analysis of relaxation processes in the magnetotail. The results of nonlinear analysis of plasma perturbations for interpretation are compared with the signals obtained by Lorentz and Weierstrass function. By virtue of recurrent diagram method, a fractal nature of experimental signals and dynamical chaos parameters. The results of satellite and numerical simulation data are compared.

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Jacobson resonance: Inertial electromagnetic induction

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One of the criticisms of general relativity is that it does not explain the concept of inertia. Mach's principle stated that the inertia of a body is somehow due to the presence of other bodies in the universe. If this is true, then it is most especially relevant to formulate an understanding of space, and its causal relation to matter. In this regard, we propose that introduction of biological models appertaining to space, quantum theory and relativity may be prerequisite for understanding the connection of space and matter, photons and phonons. A new particle-wave equation, $mc^2=BvLq$, formulates the conceptual framework for inertial electromagnetic induction (IEMI), perhaps representing the initial physical mechanism for non-ionizing radiation (NIR) bio effects. Derived from standard formulae, a new insight is introduced to provide an innovative, physiologic and efficacious approach to magneto-therapy. Specific experimental reports are cited wherein the modeling and EMF parameters were dictated by theory. It is hypothesized that Jacobson Resonance Theory is the missing link that Einstein sought for unifying the fundamental forces of nature: the electromagnetic, gravitational and nuclear forces. A generic expression for said theory may then be:

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