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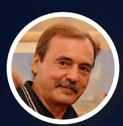

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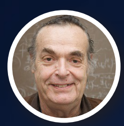

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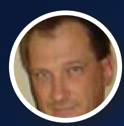

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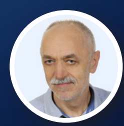

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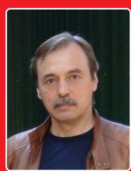

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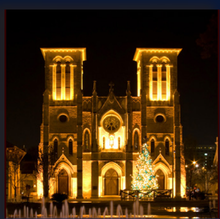
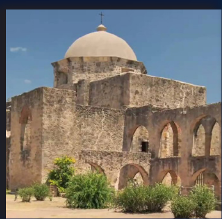
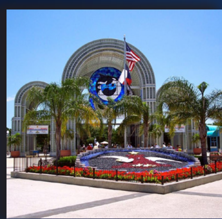


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Glimpse of Particle Physics 2016

Vasily Yu Belashov

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Solitons dynamics in regions with sharp gradients of basic parameters of propagation medium

We consider the problem of dynamics the multidimensional Solitons which are described by the generalized Kadomtsev-Petviashvili (GKP) equation in complex continuous media with varying time and/or space dispersive parameters $\beta,\gamma = f(t,\mathbf{r})$. This problem is very interesting from the point of view of its evident applications in physics of the real complex media with the dispersion. For example, such situation takes place at propagation of the 2D gravity-capillary waves on surface of shallow water when β and γ are defined as $\beta = (c_0/6)[H^2 - 3\sigma/\rho g]$ and $\gamma = (c_0/6)[H^2(\frac{2}{5}H^2 - \sigma/\rho g) - \frac{1}{2}(3\sigma/\rho g - H^2)^2]$ respectively, and ρ is the density, σ is the coefficient of surface tension of fluid and $H = H(t,x,y)$ is the depth. In this case β and γ also become the functions of the coordinates and time. Similar situation takes place at evolution of the 3D FMS waves in a plasma in case of the inhomogeneous and/or non-stationary plasma and magnetic field when β and γ are the functions of the Alfvén velocity v_A=f[B(t,r),n(t,r)] and the angle $\theta = (\mathbf{k}\hat{}\mathbf{B})$, namely: $\beta = v_A(c^2/2\omega_{0i}^2)(\cot^2\theta - m_e/m_i)$, $\gamma = v_A(c^4/8\omega_{0i}^4)[3(m_e/m_i - \cot^2\theta)^2 - 4\cot^4\theta(1+\cot^2\theta)]$. Next interesting example is the dynamics of 2D Solitons of z solar terminator and solar eclipse (SE). In this case dispersive parameters β and γ are functions of the ionospheric parameters such as electron density, temperature, scale heights for the ions and neutral particles etc. which have sharp gradients in these regions. Here, the problem of study of multidimensional Solitons dynamics $\beta,\gamma = f(t,\mathbf{r})$ with was solved in general and for above-mentioned applications.

Biography

Vasily Yu Belashov is a PhD (Radiophysics), DSci (Physics and Mathematics) holder. His main fields include: Theory and numerical simulation of the dynamics of multi-dimensional nonlinear waves, Solitons and vortex structures in plasmas and other dispersive media. Presently, he is Chief Scientist at the Kazan Federal University. He was Coordinator of studies of the International Program Solar Terminator (1987-1992), and took part in programs like WITS/WAGS and STEP. He is author of 288 publications including 6 monographs.

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O Kharshiladze, R Chanishvili and G Chagelishvili

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Linear generation of planetary scale fast magnetic waves in ionospheric zonal shear flows

We study the shear flow non-normality induced linear coupling of planetary scale modified Rossby waves and westward propagating fast magnetized waves using non-model approach. The performed analysis al-lows us to separate from each other different physical processes, grasp their interplay, and, by this way, construct the basic physics of the linear coupling of the slow and fast waves in an ionospheric incompressible zonal flow with linear shear of mean velocity, $U_0=(S_y,0)$. In this study, we will show that the modified Rossby waves generate fast magnetized waves due to the coupling for a quite wide range of ionospheric and shear flow parameters; the linear transient processes are highly anisotropic in wavenumber plane; the generation of the magnetized waves is most efficient for $S\approx0.1$ (S is the shear rate normalized to the combination of the angular velocity and latitude, $\Omega_0\cos\Theta_0$); the stream-wise wave number of the optimally generated magnetized wave harmonics decreases (the length scale increases) with increasing hall parameter, α. At the end, we will discuss nonlinear consequences of the described anisotropic linear dynamics - they should lead to anisotropy of nonlinear cascade processes

Biography

Oleg Kharshiladze is associated professor at physics department of Iv. Javakhishvili Tbilisi State University. His research interests are modeling of nonlinear dynamics and chaos pro-cesses in space plasma, radiophysics, earthquakes, application of numerical methods in non-linear differential equations. He is involved in international scientific group, working on ana-lytical and numerical analysis of ionospheric and magnetospheric processes (turbulence, shear flows, BBF and others).

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Revaz Chanishvili has published 37 papers in refereed journals. Current research interest: Shear flow non-normality induced linear mode coupling and transient growth; Turbulence in HD/MHD Atmospheric shear flows and in astrophysical disks

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Gogi Chagelishvili, Academician of The Georgian National Academy of Sciences 105 papers in refereed journals, Current research interest: Nonlinear transverse cascade in shear flow subcritical turbulence; Shear flow non-normality induced linear mode coupling and transient growth; Aeroacoustics in shear flows; Self-organization (including formation of spatio-temporal patterns) and turbulence: in HD/MHD Engineering and Atmospheric shear flows, in astrophysical disks and in Fusion plasma.

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Oleg Kharshiadze[1], Khatuna Chargazia[1], Zimbardo G[2] and Rogava J[1]

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Data analysis and simulation of plasma flow vortices in the magnetotail

ULF electromagnetic planetary waves can self-organize into vortex structures (monopole, dipole or into vortex chains). They are often detected in the plasma media, for instance in the magneto sheath, in the magnetotail and in the ionosphere. Large scale vortices may correspond to the injection scale of turbulence, so that understanding their origin is important for understanding the energy transfer processes in the geospace environment. In a recent work, the THEMIS mission has detected vortices in the magnetotail in association with the strong velocity shear of a substorm plasma flow which has conjugate vortices in the ionosphere. By analyzing the THEMIS data for that event, we found that several vortices can be detected together with the main one, and that the vortices indeed constitute a vortex chain. The study is carried out by analyzing both the velocity and the magnetic field measurements for spacecraft C and D, and by obtaining the corresponding holograms. It is found that both monopolar and bipolar vortices may be present in the magnetotail. The comparison of observations with numerical simulations of vortex formation in sheared flows is also discussed.

Biography

Prof. Oleg Kharshiladze is associated professor at physics department of Iv. Javakhishvili Tbilisi State University. His research interests are modeling of nonlinear dynamics and chaos processes in space plasma, radiophysics, earthquakes, application of numerical methods in nonlinear differential equations. 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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Prof. Gaetano Zimbardo is associate professor of space plasma physics at the University of Calabria, Italy. He received his Ph.D. from the Scuola Normale Superiore in Pisa with a thesis on Jupiter's magnetosphere. His research interests include space and astrophysical plasmas, chaos and nonlinear systems, anomalous transport of energetic particles in solar system plasmas, and particle acceleration in astrophysics, and also in the historic and educational as-pects of physics.

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Prof. Jemal Rogava received the M.S. Candidate and Doctor of physics and mathematics degrees in computational mathematics from Tbilisi State University (TSU), Georgia, in 1968, 1985 and 1997. He is a Professor at TSU from 1997 and Senior Researcher at the I. Vekua Institute of Applied Mathematics, Tbilisi. During 1990-2000, he was the Head of the Applied Mathematics Scientific Research Laboratory Georgian Technical University. His research interests include numerical analysis, mathematical modeling and applied mathematics.

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Sergey I Kopnin and Sergey I Popel

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Dusty plasma energy conversion processes in Earth's atmosphere and lunar exosphere

Energy conversion processes are considered in dusty plasmas of Earth's atmosphere and lunar exosphere. Emphasis is given to the problem of formation of dusty plasmas in the Earth's ionosphere at 80–120 km altitudes during high-speed meteor showers and that of dusty plasmas over the illuminated part of the lunar surface. Conversion of mechanical, gravitational, electrostatic, and chemical energy is considered for the situations of generation of low-frequency (~50 Hz) ionospheric radio noise, of infrasonic waves, of amplification of the intensity of green radiation at 557.7 nm from a layer at 110 to 120 km altitude in the lower ionosphere, for charged dust particle rise from the lunar surface, etc. Models of the dusty plasmas are presented. In particular, the model of dusty plasmas over the illuminated part of the moon takes account of the observation point location and the effects of production of photoelectrons at the surface of the moon and dust particles, the dynamics of dust particles in the electric and gravitational fields, and the charging of dust particles through their interaction with the solar radiation photons, the solar wind electrons and ions, photoelectrons, etc. The properties of the dusty plasmas are discussed from the viewpoint of ionospheric research and future lunar spacecraft missions.

Biography

Dr. Sergey I. Kopnin graduated with honours from the Moscow Institute of Physics and Technology in 2005 and defended his PhD thesis at the same Institute in 2008. At present, he is a senior research scientist at the Space Research Institute of the Russian Academy of Sciences, deputy dean and associate professor at the Moscow Institute of Physics and Technology. He is an expert in the fields of dusty plasma physics and physics of atmosphere. He was awarded with fellowships of the Dynasty Foundation, grant of the President of the Russian Federation for young scientists, as well as Prize of International Academic Publishing Company "Nauka/Interperiodica" for the best publication in the journals published by the Company

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Prof. Dr. Sergey I. Popel graduated with honours from the Moscow Institute of Physics and Technology (MIPT) in 1988. He defended his PhD thesis at MIPT in 1991 and DSc thesis at the General Physics Institute of the Russian Academy of Sciences in 1998. At present, he is a head of laboratory at the Space Research Institute of the Russian Academy of Sciences and full professor at the Moscow Institute of Physics and Technology. He is an expert in the fields of plasma physics and chemistry, planetary sciences, nano- and microscale objects in nature, self-organization, etc. He was awarded with Humboldt fellowship (Germany), awards of the Moscow Government and the Dynasty Foundation, Prize of International Academic Publishing Company "Nauka/Interperiodica" for the best publication in the journals published by the Company, Yu. A. Gagarin Medal of the Federation of Cosmonautics of Russia for services to cosmonautics, etc.

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Efim Pelinovsky

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Solitons gas and turbulence in the long wave hydrodynamic systems, described by the Korteweg-de Vries-type equations

Solitons are an important part of the modern nonlinear physics providing the wave propagation over long distances. In integrable systems like KdV and NLS equations, there are a lot of approaches (inverse scattering method, Darboux and Backlund transformations, bilinear Hirota method) allowing obtaining rigorous solutions for description of Solitons interaction. Solitons turbulence is specific in the theory of wave (weak) turbulence, and kinetic equations are derived here for parameters of the associated spectral problem (AKNS scheme), and not for spectral characteristics of the wave field. Vladimir Zakharov was the first who has shown it in 1971 the important role of pair collisions of Solitons within the Korteweg-de Vries equation. Then, a kinetic equation for the Solitons parameters has been developed by Gennady El with his coauthors to describe various properties of solitonic gas taking into account two Solitons elastic interaction. In our paper, we study the solitonic gas in the integrable systems described by the Korteweg-de Vries (KdV) and modified KdV equations. First of all, we investigated the features of two Solitons interaction which can influence on the statistical characteristics of a solitonic gas. Then, we compute analytically the statistical moments of solitonic gas of low density in periodic domain for the times when Solitons interaction can be ignored (for instance, if Solitons are isolated at initial time). Then, dynamics of a solitonic gas is studied numerically with use of pseudo-spectral method in periodic domain. Initially, a wave field is presented by the set of isolated Solitons with random amplitudes located on the same distance between neighbor Solitons. We studied the process of the freak wave formation in the solitonic gas described by the mKdV equation. Typical shape of freak wave in the solitonic gas is shown in Figure

Biography

Efim Pelinovsky is a PhD, and Dr. Sc. Holder. He is a Professor of Chief Scientist at the Institute of Applied Physics and State Technical University, and also Professor at Higher School of Economics. He works in the theory of nonlinear waves in hydrodynamics, ocean physics and plasma physics. He is an author of more 1o books and 500 papers. His h-index is 30 (WoS) and 32 (Scopus). His main results are: Asymptotic method for non-sinusoidal waves in dispersive media, adiabatic theory of soliton evolution in inhomogeneous medium, nonlinear sea wave run up on a coast, evaluation of coastal wave hazards, mechanisms of the freak wave phenomenon. He is a Laureate of the Russian State Prize (1997), Soloviev Medal from European Geoscience Union (2006) and award from Int. Tsunami Society (2012).

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Tatiana G Talipova and Efim N Pelinovsky

Institute of Applied Physics and Nizhny Novgorod State Technical University n.a. Alekseev, Russia

Breather-like wave dynamics in a stratified fluid

The existence of the long breathers of internal waves in a density stratified fluid, as for the existence of internal solitary waves, has been predicted by the asymptotic KdV-like theory. The long-time breather-like wave evolution in the framework of the Euler equations has been obtained numerically confirming the predictions of weakly nonlinear theory. Recently the observations of the long-wave internal breather-like waves in the Celtic Sea were published and were confirmed in numerical modeling. So the investigation of the internal breather dynamics is now hot-spot problem of the physical oceanography. Here, we address the propagation and transformation of long internal breather-like wave in an idealized but close to realistic stratification and in the conditions matching the average summer stratification in the southern part of the Baltic Sea. The focus is on changes in the properties of the breather when the water depth increases and the coefficient of the cubic nonlinear term changes its sign. Equivalently, the breather cannot exist anymore. The simulations are performed in parallel in the framework of the weakly nonlinear Gardner equation (quadratic-cubic Korteweg-de Vries equation) and using fully nonlinear Euler equations. The amplitudes of breathers in these frameworks have slightly different courses in idealized conditions (when Earth's rotation is neglected) whereas a decrease in the amplitude is faster in the fully nonlinear simulation. The impact of the background (Earth's) rotation substantially depends on the spectrum of the initial breather and the internal wave group modulation instability is studied. Fig.1 demonstrates the process of the breather generation in the three-layer fluid by transformation of the second-mode Solitons on the bottom step.

Biography

Tatiana G Talipova is a PhD, Dr. Sc. Holder and holds a position of Head Scientist at the Institute of Applied Physics and State Technical University. She works in the theory of nonlinear waves in hydrodynamics, ocean physics and plasma physics. She is an author of 5 books and 180 papers. Her h-index is 20 (WoS) and 23 (Scopus). Her main results are: Model of the transformation of nonlinear internal waves in the horizontal-variable media, study of the internal breather-like waves, mechanisms of the freak wave phenomenon, and elastic properties of the surface-active marine films.

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Efim Pelinovsky is a PhD, and Dr. Sc. Holder. He is a Professor of Chief Scientist at the Institute of Applied Physics and State Technical University, and also Professor at Higher School of Economics. He works in the theory of nonlinear waves in hydrodynamics, ocean physics and plasma physics. He is an author of more 1o books and 500 papers. His h-index is 30 (WoS) and 32 (Scopus). His main results are: Asymptotic method for non-sinusoidal waves in dispersive media, adiabatic theory of soliton evolution in inhomogeneous medium, nonlinear sea wave run up on a coast, evaluation of coastal wave hazards, mechanisms of the freak wave phenomenon. He is a Laureate of the Russian State Prize (1997), Soloviev Medal from European Geoscience Union (2006) and award from Int. Tsunami Society (2012).

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Speakers

Vasily Yu Belashov

Kazan Federal University, Russia

Multidimensional nonlinear ion-acoustic waves in a weakly relativistic plasma

The structure and dynamics of the multidimensional nonlinear ion-acoustic waves in unmagnetized plasma including the case of collisional weakly relativistic plasma when it is necessary to take into account the high energy flows of particles are studied analytically and numerically on the base of the Kadomtsev-Petviashvili (KP) equation generalized by introducing the relativistic factor u/c, when the coefficients at nonlinear and dispersive terms are defined by this ratio. In particular, when kinetic energy of the ions at $u_0/c \sim 0.1$ reaches values of ~ 4.7MeV, the 2D weakly relativistic ion-acoustic solitary waves describe a motion of energetic protons with speed approaching to speed of light, that is observed in the magnetospheric plasma. It is shown that if a speed of particles in plasma reaches speed of light then the relativistic effects at propagation of the 2D solitary ion-acoustic wave start to play rather essential role and influence phase velocity, amplitude and characteristic sizes of 2D wave. Obtained results include more simple limited cases which were considered by other authors, but they are essentially more general. The results obtained can be useful at study of nonlinear wave processes in the magnetosphere. They also have obvious applications in such physical systems as laser plasma and astrophysics (including compact astrophysical systems, for example, white dwarfs).

Biography

Prof. Vasily Yu. Belashov, PhD (Radiophysics), DSci (Physics and Mathematics). Main fields: theory and numerical simulation of the dynamics of multi-dimensional nonlinear waves, solitons and vortex structures in plasmas and other dispersive media. Presently, he is Chief Scientist at the Kazan Federal University. He is author of 288 publications including 6 monographs. Main books: Solitary Waves in Dispersive Complex Media. Theory, Simulation, Applications. Springer-Verlag GmbH, 2005; The KP Equation and its Generalizations. Theory and Applications. Magadan, NEISRI FEB RAS, 1997.

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Nonlinear dynamics of the 3D solitary Alfvén waves in the ionospheric and magnetospheric plasma

The nonlinear dynamics of the 3D solitary Alfvén waves propagating nearly parallel to the external magnetic field in plasma of ionosphere and magnetosphere, which are described by the model of the 3-DNLS equation, is studied analytically and numerically. Under the assumption of negligible dissipative effects, the analytical estimates and the sufficient conditions for the stability of 3D solutions of the 3-DNLS equation are obtained, based on the transformational properties of the system's Hamiltonian for the whole range of the equation coefficients. On the basis of asymptotic analysis the solutions asymptotics are presented. To study the evolution of the 3D Alfven solitary waves including propagation of the Alfven waves' beams in magnetized plasma, the equation are integrated numerically using the simulation codes specially developed. The results show that the 3-DNLS equation in non-dissipative case can have the stable 3D solutions in form of the 3D Alfvén Solitons (Fig.1), and also on a level with them the 3D solutions collapsing (Fig. 2) or dispersing with time. In terms of the self-focusing phenomenon, the results obtained can be interpreted as the formation of the stationary Alfvén wave beam propagating nearly parallel to magnetic field, or Alfvén wave beam spreading, or the self-focusing of the Alfvén wave beam. The influence of the dissipation in the medium on structure and character of evolution of 3D Alfvén waves is studied.

Biography

Prof. Vasily Yu. Belashov, PhD (Radiophysics), DSci (Physics and Mathematics). Main fields: theory and numerical simulation of the dynamics of multi-dimensional non-linear waves, solitons and vortex structures in plasmas and other dispersive media. Presently, he is Chief Scientist at the Kazan Federal University. He is author of 288 publications including 6 monographs. Main books: Solitary Waves in Dispersive Complex Media. Theory, Simulation, Applications. Springer-Verlag GmbH, 2005; The KP Equation and its Generalizations. Theory and Applications. Magadan, NEISRI FEB RAS, 1997.

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Dr. Elena S. Belashova, PhD (Physics of Atmosphere and Hydrosphere). Main fields: numerical simulation of the dynamics of nonlinear waves and solitons in complex dispersive media. Presently, she is Associate Professor at the Kazan National Research Technical University named after A. N. Tupolev – KAI. She is author of 50 publications including 2 monographs. Main books: Solitons: Theory, simulation, applications. Kazan, Publishing Center "School", 2016; Solitons as Mathematical and Physical Objects. Kazan, KSPEU, 2006

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Olga Khutorova, Vladislav Khutorov and Guerman Teptin

Kazan Federal University, Russia

Ionospheric disturbances during solar proton events from ground GLONASS-GPS measurements in Kazan

Statement of the Problem: This work presents investigations of possible impacts of solar proton events (SPEs) on total electron content (TEC) responses.

Methodology: We have analyzed cosmic ray variations observed by the GOES satellite instruments versus GNSS-derived ionospheric electron content variations. GPS dual-frequency ground receiver has become an excellent ionospheric remote sensing technique in accuracy (better than 0.1 TECU in Slant Total Electron Content variation). In Kazan city (56 E, 49 N), the ground-based GPS-GLONASS receiver allows us to sense total electron content one per second for small scale ionospheric disturbances investigation. We have concentrated on solar proton events on March 2012 and June 2015 to study its possible ionospheric effect. Solar event fixed by GOES monitoring instruments, which measures parameters of the near-earth solar-terrestrial electromagnetic environment [GOES Data Collection System]. During this SPE, the flux of highly energetic protons from the sun is increased to 9•105 protons/cm^2-s-sr March 8 2012 (Figure 1 top panel). Middle panel of Figure 1 shows geomagnetic field fluctuations caused by solar wind variations. The standard variation and spectra of TEC disturbances was calculated for each hour. Spectra have power-law behavior. Bottom panel of Figure 1 shows series of TEC standard variation and mean amplitudes of significant wave peaks.

Findings: The variability of the total electron content in homogeneities spectrum on scales less than 1 hour have been estimated for eveWWry second GPS phase data obtained. It is shown that in periods of increasing proton fluxes and in periods of decreasing proton fluxes on March 2012 and June 2015 the variance of total electron content fluctuations grow by increasing the intensity of the wave and turbulent processes.

Conclusion: It was found that turbulence growth and amplitude of wave disturbances increases during geomagnetic disturbances are related to proton event.

Biography

Olga Khutorova is Doctor of Science and Professor of Kazan Federal University, Institute of Physics. Her research interest areas are inhomogeneous structure of the atmosphere and at-mospheric remote sensing. She has published 216 scientific papers.

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Identify regions of generation of artificial airglow in the HF-pumped ionosphere by using TEC measurements and intensity of artificial airglow along the trajectory of GPS

Data processing synchronous measurement variations of total electron content and artificial airglow at 630 nm line of atomic oxygen observed within 2010 – 2016 in the several experimental campaigns on Sura facility is presented in this work. In ionospheric HF heating experiments using different HF-pumped modes and orientation the main beam of antenna pattern Sura facility is known. It is shown that the experiments performed under the conditions $f_oF2/f_0 \geq 1$ and $f_oF2 - f_0 \geq 0.25$ MHz, where f_oF2 - critical frequency F2 layer of ionosphere, f_0 - frequency of pumped wave, under pumped wave on, level of intensity artificial airglow increases, and while of level total electron content is reduced. In this case, regions of generation of artificial airglow located in the region of reduced electron density. In the experiments performed under the conditions $f_oF2/f_0 \leq 1$ and $f_oF2 - f_0 \leq 0.25$ MHz, we observed opposite situation, however artificial airglow in this case was weak or completely absent. This work was supported by the Russian Foundation for Basic Research (projects 17-05- 01084 and 16-32-60176) and Russian Scientific Foundation (project 14-12- 00706). Experimental data processing with the ionospheric complex cyclon was performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

Biography

Denis Kogogin received his MS degree in Radiophysics and Electronics from the Kazan Federal University, Kazan, Russia, in 2013. Since 2013, he has been a PhD student at the Department of Radio Electronics, the Kazan Federal University. He has published 4 papers in reputed journals. His research interests include nonlinear interaction of electromagnetic radiation with substance, interaction of waves and flows, active experiments in space plasma, heating experiments on ionosphere.

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Forecasting of maximum usable frequencies of HF radio channel on the basis of oblique chirp sounding

Ionosphere radio lines are widely used in the over-the-horizon radar and HF radio communications. However, due to the instability of the ionosphere the adaptation of radio systems is required to changing parameters of the ionosphere signal propagation. These radio systems operate in the decameter range.

Aim of the Work: The aim of the study is the method development of the maximum usable frequency (MUF) forecasting on the radio lines which are not provided with diagnostics using the experimental data obtained in the network of radio paths of oblique ionosphere sounding by the continuous chirp signal. The data obtained on a network of experimental radio paths were analyzed. On each radio path the ionograms of oblique sounding by chirp signals were obtained every 15 minutes. Calculations of the maximum usable frequencies by the program module MINIFTZ were used in addition to the experimental data for forecasting. Two linear forecasting algorithms were considered with the use only of experimental data and with the use of experimental data and MUF calculations by the MINIFTZ program. Besides the possibility of temporary MUF forecasting within linear prediction model was researched where the predict function uses Burg's method to calculate autocorrelation coefficients. As a result of the conducted researches, it is established that the use jointly of experimental and model data reduces an error of spatial MUF forecasting to 1-2%. In case of temporary forecasting not more than for 30 minutes, the error of linear forecasting exceeds 4%.

Biography

Alex Kolchev received his PhD at the Kazan University in 1996. His research interests include the development of experimental methods of research processes in the ionospheric plasma. They are the new methods of diagnostics of nonstationary ionospheric plasma that have been developed. He participated in the development of equipment for the Russian network of ionosonde.

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Dmitry Kulikov and Rustam Gumerov

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Multi-channel photometer for the optical measurements in the near space

In this study, the phenomena in the ionospheric plasma by the method of impact of high-power high-frequency electromagnetic waves using a different mode relatively long–up to several minutes, and the impact by short pulses – millisecond, tens of milliseconds is explained. In the first case, the most visible of heating effect is observed in the red lines of atomic oxygen (630 nm). This effect is well registered using a CCD camera. Short flashes by impact of short pulses of radio waves are observed in the green line of atomic oxygen (557.7 nm). The CCD camera has no enough speed here and the photometer based on a photomultiplier in the photon counting mode might be used. In order to get the most information in the optical wavelength in the heating experiments, we have developed a high-speed four-channel photometer with precise timing of samples. Four channels for the four photometry lines – above mentioned red and green line, and additional blue (427.8 nm, nitrogen) and infrared lines (OH) were realized. Additional requirements are the capability to control the photometer remotely and it should be maximum compact, because it will be mounted on the telescope. So, the main part of the photometer – digital block is implemented on a multi-core microcontroller of the XMOS Company. The photon counter, time module and the server are fulfilled on a microcontroller, as a console (client) using a PC or laptop. Due to its functionality, the developed device also can be used for astronomical observations.

Biography

Dmitry Kulikov has received the Specialist degree in Radio Physics and Electronics from the Kazan Federal University, Kazan, Russia, in 2012. Since 2015, he has been a MS student at the Department of Radio Electronics, the Kazan Federal University. His research interests include the development of digital equipment using the micro-controllers. His Master's work is the development the multi-channel photometer control block based on the XMOS multicore microcontroller.

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Application of multiple phase-screen calculation for radio sounding of artificial ionospheric in homogeneities

The work submits experimental data and numerical computation of radio wave propagation through ionosphere irregularities, formed at injection chemical reagents, are studied in this case. The Multiple Phase Screen (MPS) calculation consists of collapse ionospheric structure into multiple thin phase-changing screens with free-space. When the wave propagates to the ground wave, front distortion leads to the formation of interference pattern, characterized by amplitude fluctuations. The MPS method solves the parabolic wave equation and allows for direct computation of realizations of the received signal. In order to reproduce the conditions of the experiment, we fix a point of reception and consider the variation of the amplitude at this point. According to the estimates, at the intersection of the front edge of the shadow should be a sharp increase in the amplitude of the signal (the effect of the edge focusing) and then - a decline of 5-15 dB. Changing the size of the artificial plasma cloud (APC) and the decrease in the density of the electron density in it resulted in a gradual increase in the amplitude of the signal. Before the amplitude of the signal returns to its original level, there will be the second, less pronounced peak corresponding to the intersection of the second edge of the shadow. Through the development of the APC in time the picture will be asymmetric. A number of active experiments in the ionosphere with different conditions of injection, which took place on the scientific-research vessels (RV) was chosen for modeling. The results of these experiments, as well as a number of previous researches allow us to represent the APC as a large-scale formation with a higher electron density relative to the background plasma immersed in a randomly inhomogeneous medium. Dimensions of APC and density of the electron concentration were determined from ionosonde data and optical measurements. To assess the impact of large-scale component of the APC simulation was carried out for deterministic strong Gaussian lens.

Biography

Igor Nasyrov is a PhD holder in Physics. His main fields of interest include: Ionosphere, artificial ionospheric disturbances, and Sura ionospheric heating facility. Currently, he is an Associate Professor of the Institute of Physics, the Kazan Federal University (Kazan, Russia). He has published more than 20 papers in reputed journals. He is a Member of the Scientific Council of Russian Academy of Sciences on the complex problem radio waves propagation.

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Daniil Nikiforov

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The construction of three-dimensional model of the field of artificial glow of the ionosphere stimulated by powerful radio emission of Sura

For several years, Kazan Federal University has conducted experiments with the ionosphere heating by means of Sura in the optical range. In August 2014, data were obtained from two spatially separated optical observations of artificial glow of the ionosphere using the highly sensitive CCD camera with a vertical impact. The first optical measuring point was organized directly on the Vasilsursk (Nizhny Novgorod region, 56.15°N, 46.11°E). The second point was located in the magnetic observatory near Zelenodolsk (Tatarstan Republic, 55.93°N, 48.74°E). The first point was equipped with the camera S1C with the field view of about 20°. The second point was equipped with the camera KEO with the lens of the fish-eye with the field view of about 145°. The distance between points is about 166 km. The experiment is represented schematically in the Figure. The work is devoted to determine the geometric dimensions of the area of artificial glow of the ionosphere on two measuring points at a wavelength λ = 630 nm stimulated by powerful radio emission of Sura. To perform the work necessary to solve several problems firstly, the image is applied to the azimuthal coordinate grid in order to determine orientation of the camera. Secondly, choose the optimal algorithm for processing in order to separate the area of artificial glow, as well as choose a pair of images from different cameras synchronized by time. Thirdly, to build a three-dimensional model of the experiment by placing virtual cameras at a distance equivalent to the distance between points, and lifting the object to the height at which the glow is recorded. After completing tasks, with the aid of the editing object, we can choose a model that most clearly reflects the contours of glow area with the real images.

Biography

Daniil Nikiforov is a student of the Institute of Physics of Kazan Federal University. After completing his high school, he was accepted to the Institute of Physics. He is interested in Basic Sciences. His scientific direction is to study the effects on the ionosphere by powerful radio emission in the optical range. He shows interest to take part in the experiments on the effects on the ionosphere by powerful radio emission of Sura. He takes part in scientific-practical conferences of the University. He deals with processing of experimental data.

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Marat N Ovchinnikov, Galiya G Kushtanova and Alexander G Gavrilov

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Hydrodynamic waves and disturbances in nonlinear porous media and filtration parameters estimation

The saturated porous media are heterogeneous under natural conditions in most situations. This fact complicates the calculation of the filtration parameters such as transmissibility and diffusivity coefficient and there is an additional difficulty associated with the nonlinearity also. First of all we have to note the essential permeability nonlinear dependence from the pressure in fracture porous media. Thus, the problem of the heterogeneity and nonlinearity contributions separating emerges when we run the buildup well tests. In this case appropriate results can be obtained using pulse tests and multiple pulses tests in the form of harmonic waves in addition to the standard buildup tests. We have studied the shape of the time dependence pressure curves using numerical simulation of nonlinear diffusivity equation. The dependence of the permeability on the pressure was approximated by realistic exponential and hyperbolic functions. The results of research show the possibility of the nonlinearity influence separation on the integral shape of the pressure curves.

Biography

Marat Nicolaevich Ovchinnikov, doctor of physical and mathematical sciences, professor, head of the radioelectronic chair of the Kazan Federal University, Kazan, the Russian Federation. Expert in the field of the hydrodynamics.

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Timur Prokhorov

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Calculation of ionospheric penetration points for GPS navigation satellites

The algorithm of calculating the position and over flight time of ionospheric penetration points for GPS navigation satellites in the field of the antenna pattern (AP) of Sura facility (r/p Vasilsursk, Nizhny Novgorod Region, NNSU) and ionosonde Cyclone (r/p Orekhovka, Republic of Tatarstan, KFU) is shown in the report. Calculation of ionospheric penetration points of GPS satellites is needed to determine the interval of finding satellites within the AP and further calculation of the total electron content (TEC). Determination of the TEC will allow diagnosing the state of the ionospheric plasma and the main parameters of the emerging large-scale disturbances within the disturbed region of the ionosphere limited by angular size of the AP.

Biography

Timur Prokhorov is the student of Kazan Federal University. He is learning and engaged in research activities at the Department of Radio Electronics. His previous work was about programming analog integrated circuits. But now, he has interest to study the state of the ionosphere, because this is one of the main directions of scientific activities at the department.

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The influence of M7.3 class solar x-ray burst on the disturbance of the lower ionosphere as well as HF propagation characteristics

Earth's ionosphere is a plasma state of the atmospheric gas at altitudes above 60 km of the ground. The radiation from solar flares causes ionospheric disturbances. X-rays are the high-energy radiation. It changes a state of the plasma in the lower ionosphere. This effect is called a sudden-ionospheric disturbance (SID). X-ray flares are classified as: A, B, C, M, X. As a result, the SID electron concentration in lower ionosphere (mainly in the area D) increases quickly (a few minutes), and has a slower decline (generally within one or two hours). There is maximum absorption of HF radio waves due to the large number of the collision in the lower ionosphere at these altitudes. Strong perturbations can lead to full absorption of HF in a wide frequency band (called blackout effect). Blackouts are categorized depending on the power flares: R1-R5. The study of perturbations caused by X-ray flares is perhaps of different ways. We have used a passive LFM sounder on the path Cyprus - Yoshkar-Ola. We obtained variations of frequency dependences of signal power in the HF range. Figure 1 shows variation of the current frequency dependencies of power with SID for blackout of class R2. We found a synchronous variation of signal power ratio following the variation of X-ray intensity in the case of blackout at frequencies below 16 MHz. We assumed that the relaxation of the considered events is described by the exponential law for the relaxation time as well as obtained the following values:

Thus, the relaxation time of the blackout is 1.7 times more relaxation time of the X-ray radiation of a sun flare. Thus, the blackout effect reduces the frequency capacity of the multidimensional HF channel. Let us assume that the band pass of a partial channel is 3 kHz then we could organize ~ 7660 channels in the case of absence of disturbance at the radio path Cyprus - Yoshkar-Ola. Class R2 blackout could lead to their reduction to the number of ~ 5056, i.e. decreasing by 34%.

Biography

Ryabova Maria Igorevna – Candidate of Physics and Mathematics, Associate Professor of the Chair of Higher Mathematics at Volga State University of Technology. The sphere of scientific interests is the modeling of technical systems, the propagation of radio waves. The author of 89 publications.

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Ionospheric wave disturbances generated by the solar terminator using GPS

Investigation of the influence of the solar terminator (ST) in the Earth's ionosphere is an important task of ionospheric physics. With the new GPS-radio sounding technology to study the ionosphere, significant progress has been made. It has been found that ST is the generation of perturbation wave in the ionosphere. According to measurements GPS was found that these disturbances are observed in the form of wave packets in TEC. GPS observation variations allow the study of regular TEC variation, such as cyclic, seasonal, diurnal, identifying different kinds of trends and longer periods. The aim is to study the ionospheric wave disturbances generated by the solar terminator during sunrise and sunset, with the help of signals of global satellite radio navigation system GPS. To achieve this goal, we have solved a number of problems like the orbital motion of the satellites built systems GPS of the Volga Federal District; processed and calculated the TEC from the experimental data obtained from GNSS receivers located in Kazan (KZN) and the astronomical observatory. V P Engelhardt (EAO), TEC identified variations associated with the movement of the morning and night terminator. Collected data for the period from 01.01.16 to 31.12.16 on two sites (Kazan Federal University, KFU, Engelgardt Astronomical Observatory, EAO) were processed. For each day of the theoretical and experimental ST for each item, the orbital motion of satellites was calculated. It was found that in the winter time 35% and in summer time, 40%-45% of cases recorded the occurrence of TEC variations during the passage ST.

Biography

Sherboev Murodjon completed his under graduation studies from Tajik National University, Dushanbe, Tajikistan in 2014. Currently, he is a graduate student of the Department of Radio Electronics, Kazan Federal University, Kazan, Russia. His research interests include the study of natural and anthropogenic ionospheric irregularities by radio occultation, the study of ionospheric wave disturbances generated by the solar terminator with GPS

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TIDs investigation by two-dimensional TEC mapping and ionosonde

Simultaneous observations of the ionosphere using the ionosonde and dense GPS/GLONASS receiver's network allow us to investigate TIDs parameters by two independent methods. Two-dimensional TEC perturbation maps using 150 GPS/GLONASS receivers were obtained. The distance between the network cells is about 40 km and the temporal resolution of the network is 30 seconds. The ionosonde works in one minute cadence. The ionosonde is located inside the GPS/GLONASS sounding area. Daytime MSTIDs with wave fronts stretching in NE–SW direction are observed on TEC maps. These structures propagate south eastward at the velocity of 100–150 m/s. Their wavelengths are 250-300 km and amplitudes are larger than 0.4 TECU. For the same time the ionogram variations of F2-peak plasma frequency with peak-to-peak amplitude near 0.3 MHz are observed. The periods of TEC perturbations and F2-peak frequency variations are close (~40 min). The maximum deviation of F2-peak frequency corresponds to minimum value of TEC perturbation over the ionosonde.

Biography

Sherstyukov Ruslan is a Postgraduate student of Kazan Federal University. He is the author of 6 publications.

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Nonlinear distortion effects of the probing signal in the diagnostics and control of feeders of the radio astronomy systems

In modern space studies on board of the spacecrafts at operation of antenna systems and systems of communication and control a number of problems associated with the transmission of signals in the proper circuits takes place, that directly affects not only the correct work of the equipment, but also the quality and representativeness of obtained experimental information. We have developed a method of the construction of diagnostic equipment that can be efficient for detecting both single and multiple combinational defects with a sufficiently high accuracy, which is based on a proposed echo-location diagnostic technique. The essence of the method is use of a probing signal in the form of sequentially formed harmonic oscillations of several different frequencies with further common processing of received reflected signals. On the basis of this method the possibilities of improving the qualitative indices of the diagnostic equipment are considered. Nevertheless, at diagnostics and control of feeders of radio-astronomical systems by use of the method of the synthesized video signal there are number of questions, for example such as a possibility of due accounting of the nonlinear effects in communication lines of complex geometry with multiple combinational defects. Besides, it should be noted that existence of the dispersion in the communication line leads to distortion of the original waveform of a signal at its propagation, and degree of influence of distortions increases with the removal of the defects from the beginning of the communication line. Thereby, the presence of dispersion is one of the limiting factors. So, the distortions increase with distance increasing and at decreasing of frequency. Thus, the accounting for nonlinear and dispersion effects enables us to consider more general case. The solution of this problem in studies of propagation of the probing synthesized video signal is based on using of the model constructed on the basis of set of KdV-class equations for long communication lines with nonlinear elements. At this, one can observe some effects, such as the dispersion of the propagating current and voltage pulses with time, and formation of high-frequency sequences of the stable soliton-like structures, and also a phenomenon of parametric amplification of a signal.

Biography

Dr. Ludmila Yu. Fadeeva, PhD (Devices and Methods of Control). Main fields: theory and numerical simulation in the electrodynamics, radio waves, radio engineering, construction of diagnostic equipment, diagnostics and control of communication lines and antenna system. Presently, she is Associate Professor and deputy Dean at the Kazan National Research Technical University named after A. N. Tupolev – KAI.

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Prof. Vasily Yu. Belashov, PhD (Radiophysics), DSci (Physics and Mathematics). Main fields: theory and numerical simulation of the dynamics of multi-dimensional nonlinear waves, solitons and vortex structures in plasmas and other dispersive media. Presently, he is Chief Scientist at the Kazan Federal University. He is author of 288 publications including 6 monographs. Main books: Solitary Waves in Dispersive Complex Media. Theory, Simulation, Applications. Springer-Verlag GmbH, 2005; The KP Equation and its Generalizations. Theory and Applications. Magadan, NEISRI FEB RAS, 1997.

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The study of the ionosphere disturbed volume over the SURA facility using vertically sounding ionosonde

Digital ionosonde near from Kazan enables us to sound the disturbed region of the ionosphere over the SURA ionospheric heating facility and measure the characteristics of artificial ionospheric irregularities. In this paper we study some ionospheric effects.

The experiments were carried on September 14, 2015. The SURA antenna pattern was directed to zenith. The ionosonde "Cyclon" of Kazan Federal University operated every 15 min in the ionogram mode. Ionograms were recorded for 20 seconds; in the rest of time ionosonde emitted and received at 10 fixed frequencies. Figure 1 shows that this method enables us to obtain information about the characteristics of generation and relaxation of artificial ionospheric irregularities at various altitudes. The frequency 4375 kHz of the receiving channel of the ionosonde corresponds to the frequency of the wave SURA facility in this measurement session. Characteristics of the ionosonde "Cyclon" can be found in our previous works An analysis of the experimental results indicated that beside typical observed scattered signals we observed a signal, which has "week diffusion" that corresponds to specular reflection of radio waves in the ionosphere and that must come from the local area enough. We tried to interpret the phenomenon by the zenith of magnetic field, where the development of the most intense plasma density perturbations is observed within the range from meters to tens of kilometers. Such a structure of disturbed region leads to strong distortions of the refractive sounding radio waves and to the appearance of narrow frequency bands, which may be the conditions of aspect scattering or specular reflection. It is necessary to perform modeling of propagation conditions in the disturbed ionosphere for a clear clarification of the nature of this "week diffusion" signal.

Biography

Dr. Zykov Evgeniy.Yurevich, PhD (Radiophysics), Main fields: ionosphere, ionosondes, autoscaling ionograms. Presently, he is Associate Professor at the Kazan Federal University (Kazan).

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