Ahmedov Bobomurat

Position: Project Leader/Professor

I Scientific Work

My main duty is to carry out the theoretical research in the field of electrodynamics of continuous media in general relativity and relativistic astrophysics and observational research on GPS and VLF data analysis for ionospheric disturbances caused by various atmospheric, terrestrial and extraterrestrial phenomena. At present I am holding a position of Projects Leader and Head of Sector of Theoretical Astrophysics (affiliated to the AS-ICTP as PRJ-29) in the Institute of Nuclear Physics, position of Leading Researcher and Projects Leader (part time) at the Ulugh Beg Astronomical Institute in Tashkent and position of Full Professor (part time) at the Uzbekistan National University in Tashkent and Tashkent Pedagogical University. I was co-organizer of Int. Symposium on Experimental Gravitation held in Samarkand, Uzbekistan, 1999. I am delivering lectures to graduate students at Samarkand State University starting year 1993 and at Uzbekistan National University, Tashkent from year 2000. I plan to give lectures at the Tashkent Pedagogical University starting this year. I am a key person being responsible for Uzbekistan in AS-ICTP Network on Relativity, Astrophysics and Cosmology between Bangladesh, India, Pakistan, Turkey and Uzbekistan (BIPTUN). I am Vice-Chairman of Scientific Council D.067.02.13 awarding PhD/DrSc degrees in Astrophysics and Radioastronomy & Theoretical Physics at the Uzbekistan National University and have full responsibility for PhD/DrSc dissertation defenses in Astrophysics and Radioastronomy in Uzbekistan. I am member of Scientific Councils at the Ulugh Beg Astronomical Institute and at the Institute of Nuclear Physics, Tashkent.

My research is mainly devoted to the general-relativistic electrodynamics of continuous media such as superconductor, conductor, plasma etc and its application for theoretical explanation and analysis of EM (electromagnetic) and astrophysical processes in the external gravitational fields. Experimental tests of general relativity, general relativistic EM effects and fields for pulsars and magnetized rotating and oscillating neutron stars are also in my scientific interests. Recently I have started a research on VLF (very low frequency) EM wave propagation in Earth ionosphere and study of the ionospheric disturbances caused by various atmospheric, terrestrial and extraterrestrial phenomena.

RESUME OF CURRENT RESEARCH

The basic equations of the GR EM fields in plasma magnetosphere of an oscillating magnetized neutron star have been formulated. The GR boundary conditions for discontinuities of EM fields at the surface of oscillating star are obtained. The Maxwell equations are investigated under the assumption of quasistationarity and low current approximation in plasma magnetosphere around oscillating relativistic star. Expressions for interior EM fields of a relativistic oscillating spherical star inside the perfectly conducting crust of oscillating magnetized star in the interior Schwarzschild

metric in case of infinite conductivity are obtained. General relativistic expressions for the EM fields interior of oscillating conducting crust of magnetized NS with polytrophic equation of state have been found.

Numerical solutions for space charge density and electric field in plasma magnetosphere for various modes of toroidal and spheroidal oscillations of Schwarzschild star have been obtained. The results justify that near the surface of oscillating magnetized neutron star the space charge density and electric field will be modified by the strong gravitational field. GR effects lead to shrinking of the size of the polar cap and an increase in the energy density of the outflowing plasma. These effects act in opposite directions but the net result is that the energy loss from the NS is significantly smaller than suggested by the Newtonian treatment.

The impact that stellar oscillations have on electric and magnetic fields external to a relativistic magnetized star in vacuum has been investigated. Modelling the star as a relativistic polytrope with infinite conductivity, the solution of the general relativistic Maxwell equations both in the vicinity of the stellar surface and far from it has been found. The general relativistic energy loss through EM radiation for different type (radial, toroidal and spheroidal) oscillations of relativistic magnetized stars has been calculated. GR corrections to EM fields lead to a damping timescale due to EM losses which is at least one order of magnitude smaller than its Newtonian counterpart; the emission of GW represents the most efficient mechanism for the damping of p- and f-mode oscillations; EM losses represents the most efficient mechanism for the damping of g-mode oscillations.

The dipolar magnetic field configuration in dependence on brane tension and present solutions of Maxwell equations in the internal and external background spacetime of a magnetized spherical star in a Randall-Sundrum II type braneworld. The star is modelled as sphere consisting of perfect highly magnetized fluid with infinite conductivity and frozen-in dipolar magnetic field. With respect to solutions for magnetic fields found in the Schwarzschild spacetime brane tension introduces enhancing corrections both to the interior and the exterior magnetic field. These corrections could be relevant for the magnetic fields of magnetized compact objects as pulsars and magnetars and may provide the observational evidence for the brane tension through the modification of formula for magneto-dipolar emission which gives amplification of EM energy loss up to few orders depending on the value of the brane tension.

Analytical solutions of Maxwell equations in background spacetime of BH (black hole) in braneworld immersed in external uniform magnetic field have been found. Influence of both magnetic and brane parameters on effective potential of the radial motion of charged test particle around slowly rotating in braneworld immersed in uniform magnetic field has been investigated by using Hamilton-Jacobi method. Exact analytical solution for dependence of the radius of the innermost stable circular orbits (ISCO) from brane parameter for motion of test particle around nonrotating isolated black hole in braneworld has been derived. It has been shown that radius ISCO is monotonically growing with the increase of module of brane tidal charge. Comparison of the predictions on ISCO radius of the brane world model and of the observational results of ISCO from relativistic accretion disks around black holes provided upper limit for brane tidal charge.

Analytic general relativistic solutions for the EM fields external to a slowly-rotating magnetized NUT star with nonvanishing gravitomagnetic charge are found. It is shown that the general relativistic corrections due to gravitomagnetic charge are not present in the form of the stationary magnetic fields but emerge only in the form of the electric fields. The gravitomagnetic charge provides an additional induced EF being analogous to the one introduced by the rotation of the star in the flat spacetime limit.

The general relativistic Ohm's law for the conduction current where the gravitomagnetic terms are incorporated has been derived. Then it is applied to predict a new galvano-gravitomagnetic effect, which takes place when a current carrying conductor is placed in a gravitomagnetic field. In connection with this galvano¬gravitomagnetic effect, the possibility of using current carrying conductors for detecting the Lense-Thirring field of the Earth was explored.

The general relativistic formula for charge distribution inside conductors has been derived from the Maxwell equations with the help of constitutive relations. The measurements of the general relativistic effect of charge redistribution inside conductors which can be performed within a conductor in the presence of gravitational field of a slow rotating metric source and an applied magnetic field both are proposed. It is shown that superconducting quantum interferometers could not detect the gravitomagnetism in the space of charged capacitor since they measure the quantity including the sum of electric and magnetic fields, and the general-relativistic magnetic part will be totally cancelled by the electric one which is in agreement with the experiments.

The appearance of general-relativistic contribution to the magnetic flux through a superconducting thermoelectric bimetallic circuit is shown. A response of the Josephson junctions to a heat flow is investigated in the general¬relativistic framework. Some gravitothermoelectric effects which can be observed in the superconducting state in the earth's gravitational field are considered.

Analytic solutions of Maxwell equations in the internal and external background spacetime of a slowly rotating misaligned magnetized neutron star have been obtained. With respect to a flat spacetime solution, general relativity introduces corrections related both to the monopolar and the dipolar parts of the gravitational field. In particular, in the case of infinite electrical conductivity general relativistic corrections due to the dragging of reference frames are present, but only in the expression for the electric field. In the case of finite electrical conductivity, however, corrections due both to the spacetime curvature and to the dragging of reference frames are shown to be present in the induction equation, which could be relevant for the evolution of the magnetic fields of pulsars and magnetars.

Electrostatic plasma modes along the open field lines of a rotating neutron star and Goldreich-Julian charge density in general relativity are analyzed for the neutron star with zero inclination. It is found that the charge density is maximum at the polar cap and it remains almost same in certain extended region of the pole. For a steady state Goldreich-Julian charge density the usual plasma oscillation along the field lines are found; plasma frequency resembles to the gravitational redshift close to the Schwarzchild radius. The nonlinear plasma mode along the field lines is studied. From the system of equations under general relativity, a second order differential equation is derived. The equation contains a term which describes the growing plasma modes near Schwarzchild radius in a black hole environment. The term vanishes with the distance far away from the gravitating object.

For initially zero potential and field on the surface of a neutron star, Goldreich-Julian charge density is found to create the plasma mode, which is enhanced and propagates almost without damping along the open field lines.

The equations that describe the EM processes in a plasma surrounding a neutron star are obtained by using the general relativistic form of Maxwell equations in a geometry of slow rotating gravitational object. A new mechanism of the generation of azimuthal current under the gravitomagnetic effect on radial current in a plasma around neutron star is predicted. The azimuthal current being proportional to the Lense-Thirring angular velocity can give valuable contribution on the evolution of the stellar magnetic field in some cases and therefore in general relativity a rotating neutron star, embedded in plasma, can in principle generate axial-symmetric magnetic fields even in axisymmetry.

The influence of the general-relativistic effects on charge distribution inside neutron star is investigated. The qualitative distinction of space charge distribution inside conducting crust from that inside superconducting core allows us to propose a possible mechanism of radio-wave radiation produced inside pulsar. A possibility of modelling this radiation in laboratory experiments in rotating frame of reference is analyzed.

It has been proposed that ionospheric disturbances before earthquakes, may have influence on the propagation of radio waves and, therefore, be precursors of EM signals detectable from ground- and space-based measurements. Analytical solution for the electric current arising in the lower ionosphere due to ejection of charged aerosols from the ground before earthquake is found and energy losses of the EM wave propagating through this layer of ionosphere are explored. Corrections to the "group delay" of the EM wave, Faraday rotation of the polarization plane and Doppler frequency shift, caused by electron density inhomogeneities induced in the higher layers of the ionosphere before earthquakes are studied.

On 22-Aug-2008 an earthquake with magnitude M=6.5 occurred in Tashkent, Uzbekistan where from May 2008 a VLF radio receiver provided by the STAR Laboratory of Stanford University is into operation. The raw analysis of VLF radio paths revealed a clear increase in the amplitude of the radio signals exactly at the time of the earthquake occurrence. Data from two GPS stations operated by Ulugh Beg Astronomical Institute and located in Tashkent and Kitab has been analyzed for possible earthquake ionospheric precursors. TEC (total electron content in ionosphere) time series over both sites are produced and applied to detect anomalous TEC signals accompanying the earthquakes. Anomalous TEC signals and significant correlation in time between these TEC anomalies and the occurrence of earthquake in Tashkent on 22-Aug-2008 have been detected. The deflection amplitude of maximum value of TEC over Tashkent reached about 20-30 with compare to the nondisturbed initial monthly mean background value one day before and after the earthquake. Exactly at the time of the earthquake occurrence TEC drastically dropped and came back near to the typical value after about 5 hours. This result does prove the possibility of precursory phenomena and show that the TEC precursor signature is enough to be detected by the GPS data analysis techniques. The localness of seismo-ionospheric TEC variation is demonstrated by the fact that no essential deflection was observer over Kitab GPS station which is at the distance of about 300 km from the epicenter.

II Conferences and educational activities

Conferences and Other External Scientific Work

The First IHY Int. Workshop on Advancing Very Low Freq.(VLF) Science Through the Global AWESOME Network, Tunis 2009
2nd Int Conf & Advances School Turbulent Mixing and Beyond, AS-ICTP, Trieste, Italy 2009
Summer College on Plasma Physics, AS-ICTP Trieste, Italy

Work With PhD Students

Ahmadjon Abdujabbarov, PhD Defence, Uzbekistan National University, Tashkent, June 18, 2009, Particle Motion and Electromagnetic Fields of Axial Symmetric Compact Objects in General Relativity

Viktoriya Giryanskaya, PhD Defence, Uzbekistan National University, Tashkent, March, 2010 (expected), Effects of General Relativity for Axial Symmetric Gravitational Models and Their Application to Astrophysics of Compact Objects

Rakhmatov Nemat, PhD Defence, Uzbekistan National University, Tashkent, 2010 (expected), General Relativistic Observable Macroscopic Effects in Electrodynamics

Diploma thesis supervision

Viktoriya Giryanskaya, MSc Defence, Uzbekistan National University, Tashkent, 2009, Plasma modes along open field lines of magnetized neutron stars

Abdikamalov Ernazar, MSc Defence, Uzbekistan National University, Tashkent, 2005, General Relativistic Plasma Magnetosphere of Magnetized Oscillating Stars

Kagramanova Valeria, MSc Defence, Uzbekistan National University, Tashkent, 2006, Observable Effects of General Relativity in Stationary Gravitational Fields

Fattoyev Farrukh, MSc Defence, Uzbekistan National University, Tashkent, 2004, Quasistationary Electromagnetic Effects in Gravitational Field

Rakhimov Ozodbek, MSc Defence, Uzbekistan National University, Tashkent, 2008, Particle Motion in Stationary Axial Symmetric Gravitational Field

Abdujabbarov Ahmadjon, MSc Defence, Uzbekistan National University, Tashkent, 2007, Thermoelectric Instability in Magnetized Neutron Stars

Slava Giryanskiy, MSc Defence, Uzbekistan National University, Tashkent, 2009, Electromagnetic fields of oscillating magnetized relativistic stars

Sardor Tojiev, MSc Defence, Uzbekistan National University, Tashkent, June, 2010 (expected), Electromagnetic Ionospheric Phenomena and Monitoring of F and D Layers of Ionosphere of Earth

Sanjar Shaymatov, MSc Defence, Uzbekistan National University, Tashkent, June, 2010 (expected), VLF (Very Low Frequency Electromagnetic Waves) Data Analysis in MatLab Programming

Other Teaching Duties

Teaching Experience

Winter-spring term 2009: Course in Statistical Physics and Thermodynamics, II part (66 lecture hours) for the 4th year undergraduate students (Bachelor Course), Chair of Theoretical Physics, Faculty of Physics, Uzbekistan National University, Tashkent, Uzbekistan.

Winter-spring term 2009: Course in General Relativity and Gravitation (50 lecture hours) for the 1st year graduate students (Master Course), Chair of Theoretical Physics, Faculty of Physics, Uzbekistan National University, Tashkent, Uzbekistan.

Winter-spring term 2009: Course in Statistical Physics and Thermodynamics (66 lecture hours) for the 3rd year undergraduate students (Bachelor Course), Chair of Theoretical Physics, Faculty of Physics, Uzbekistan National University, Tashkent, Uzbekistan.

Fall term 2009: Course in Statistical Physics and Thermodynamics, I part (60 lecture hours) for the 4th year undergraduate students (Bachelor Course), Chair of Theoretical Physics, Faculty of Physics, Uzbekistan National University, Tashkent, Uzbekistan.

Fall term 2009: Course in General Relativity and Cosmology (75 lecture hours) for the 1th year graduate students (Master Course), Chair of Astronomy, Faculty of Physics and Mathematics, Tashkent Pedagogical University, Uzbekistan.

Fall term 2009: Course in Basics of Cosmic Electrodynamics, I part (83 lecture hours) for the 1th year graduate students (Master Course), Chair of Astronomy, Faculty of Physics and Mathematics, Tashkent Pedagogical University, Uzbekistan.

Winter-spring term 2010: Course in Statistical Physics and Thermodynamics, II part (66 lecture hours) for the 4th year undergraduate students (Bachelor Course), Chair of Theoretical Physics, Faculty of Physics, Uzbekistan National University, Tashkent, Uzbekistan.

Winter-spring term 2010: Course in General Relativity and Gravitation (50 lecture hours) for the 1st year graduate students (Master Course), Chair of Theoretical Physics, Faculty of Physics, Uzbekistan National University, Tashkent, Uzbekistan.

Winter-spring term 2010: Course in Basics of Cosmic Electrodynamics, II part (84 lecture hours) for the 1th year graduate students (Master Course), Chair of Astronomy, Faculty of Physics and Mathematics, Tashkent Pedagogical University, Uzbekistan.

Other

AS-ICTP Regular Associate, Trieste, Italy, 2005-2010

Leader of 4.5 Years Research Project *"Study of the Equations of Electromagnetic and Gravitational Fields in Relativistic Astrophysics and Cosmology"* from the Uzbekistan Academy of Sciences, Grant FA-F2-F079, Tashkent, Uzbekistan (1 July 2007 - 31 December 2011).

Co-Leader of 4.5 Years Research Project *"Study of Gravitational Lenses, Formed Galaxies and Generalized Gravitational Models"* from the Uzbekistan Academy of Sciences, Grant FA-F2-F061, Tashkent, Uzbekistan (1 July 2007 - 31 December 2011).

Co-Leader of 3 Years Research Project *"Monitoring of Very Low Frequency Signals in Earth Ionosphere for Prognosis of Dangerous Tectonic Phenomena"* from the Uzbekistan Academy of Sciences, Grant FA-A17-077, Tashkent, Uzbekistan (1 January 2009 - 31 December 2011).

Leader of 2 Years Research Project *"General Relativistic Effects in Axial Symmetric Spacetimes"* from the Foundation for Fundamental Studies of the Uzbekistan Academy of Sciences, Grant #5-08, Tashkent, Uzbekistan (1 January 2008 - 31 December 2009).

DAAD (Germany) Grant A/09/04164 , 2009

Vice-Chairman of Scientific Council D.067.02.13 awarding PhD/DrSc degrees in Astrophysics and Radioastronomy & Theoretical Physics at the Uzbekistan National University (starting January 2009).

2009 List of Publications

Abdikamalov E.B., **Ahmedov B.J.,** and Miller J.C., The Magnetosphere of Oscillating Neutron Stars in General Relativity, **Mon. Not. R. Astron. Soc.,** 2009, Vol. 395, Issue 10, pp. 443-461.

Ahmedov B.J. and Morozova V.S. "Plasma Magnetosphere Formation Around Oscillating Magnetized Neutron Stars", **Astrophys. Space Sci.**, 2009, V. 319, 115-117.

B.V. Turimov, **B.J. Ahmedov,** A.A. Abdujabbarov, Electromagnetic Fields of Slowly Rotating Magnetized Gravastars, **Modern Physics Letters A**, 2009, V. 24, No. 10, 733-737.

A.A. Abdujabbarov, **B.J. Ahmedov** Electromagnetic Fields and Charged Particle Motion Around Magnetized Wormholes, **Astrophys. Space Sci.**, 2009, V. 321, 225–232.

V. Morozova and **B.J. Ahmedov,** Quantum Interference Effects in Slowly Rotating NUT Space-time, **Int. J. Mod. Phys. D**, 2009, V.18, No.1, pp. 107-119.

A.A. Abdujabbarov, **B.J. Ahmedov,** Charged Particle Motion Around Rotating Black Hole in Braneworld Immersed in Magnetic Field, **Phys. Rev. D**., 2009, submitted.