

## VILNIUS UNIVERSITY RESEARCH INSTITUTE OF THEORETICAL PHYSICS AND ASTRONOMY



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**Director** – Habil. Dr. *Gražina Tautvaišienė*

### **STAFF**

62 researchers and other investigators (15 habilitated doctors, 33 doctors, and 10 doctoral students). Full staff comprises 102 people. Planetarium employs the staff of 16 persons.

### **STRUCTURE**

**Astronomical Observatory (AO)**

**Head** – Habil. Dr. *Gražina Tautvaišienė*, tel. 261 09 59

**Department of the Theory of an Atom (DTA)**

**Head** – Dr. *Alicija Kupliauskienė*, tel. 212 53 61

**Department of the Theory of Nucleus (DTN)**

**Head** - Dr. *Egidijus Norvaišas*, tel. 261 29 06

**Department of the Theory of Processes and Structures (DTPS)**

**Head** – Prof. Habil. Dr. *Bronislovas Kaulakys*, tel. 262 08 59

### **Chair of Studies**

**Head** – Dr. *Gintaras Merkelis*, tel. 261 05 02

### **The Institute is the Incorporator of Planetarium in Vilnius**

**Director** – *Danutė Sperauskienė*, tel. 272 41 77

### **MAIN RESEACH TRENDS AND INTERESTS**

Development of effective methods of mathematical physics and their application to theoretical investigation of many-particle systems, their nonlinear dynamics and of quantum fields

Studies of atoms, subatomic particles, molecules, their structures and plasma spectroscopy, their application to nanophysics and astrophysics

Investigations of the structure and evolution of the Galaxy, stars and interstellar matter

### **The principal subjects of research in the Departments of the Institute in 2008:**

Stellar photometry and spectroscopy, classification of stars, Galactic structure and dynamics, interstellar extinction, modeling of stellar systems, orbits of small bodies of the Solar system (AO)

Theoretical atomic spectroscopy, methods of the theory of complex atomic and ionic spectra, development of quantum many-body theory, processes of the interaction of polarized atoms with polarized electrons and photons; algorithms and computer programs for fusion plasma physics and astrophysics (DTA)

Development of the algebraic techniques of the nuclear and particle physics, investigations of microscopic collective models of atomic nuclei, the quantified field models of elementary particles (DTN)

Dynamical processes in the strongly driven nonlinear systems; structure of spectra of molecules; model Hamiltonian matrices and the graph-theoretical models; quantum optics of dielectrics; quantum electrodynamics, photo physical processes; Bose-Einstein condensates; phase transitions; fluctuations and noise, theory of 1/f noise; econophysics and physics of finance Highly sensitive chemical measurements by methods of optical spectrometry, metrology of chemical measurements, their application to the environmental science (DTPS)

### **CONFERENCES AND SEMINARS ORGANIZED IN 2009**

13<sup>th</sup> International Workshop on New Approaches to High-Tech: Nano Design, Technology, Computer Simulations (NDTCS-2009)

BalticGrid-II summer school

**RESEARCH PROJECTS CARRIED OUT IN 2009**

**Projects Supported by Institute Budget**

**The Chemical Composition and Evolution of Stellar Atmosphere.** Habil. Dr. G. Tautvaišienė. 2005–2009.

**Positional Astrometry of Unusual Asteroids and Comets.** Dr. K. Černis. 2005–2009.

**Star Forming Region and Dust Clouds in the Second Galaxy Quadrant.** Prof. V. Straizys. 2006–2009.

**Population Characteristics of Orbital Visual Binary Stars.** Prof. A. Bartkevičius. 2007–2009.

**Investigation of the Possibilities of the Spectrophotometric Classification of Reddered Stars.** Habil. Dr. K. Zdanavičius. 2006–2009.

**Optical Properties of Cold Atoms and Condensed Structures: Development of the Theory.** Habil. Dr. G. Juzeliūnas. 2005–2009.

**Theoretical Studies of Electron Spectra and Chemical Reactivity of Polyatomic Compounds.** Habil. Dr. V. Gineitytė. 2005–2009.

**Power Laws and 1/f Fluctuations in Dynamical Chaotic and Stochastic Systems.** Prof. B. Kaulakys. 2005–2009.

**Investigation of Subatomic Systems and Their Dynamics by the Methods of Group Theory and Topology.** Habil. Dr. S. Ališauskas, Dr. E. Norvaišas. 2007–2010.

**The Cascades in Complex Atoms and Their Influence on X-ray and Auger Spectra: Theory and Interpretation.** Prof. R. Karazija. 2005–2009.

**Fluorescence and Auger Emission of Polarized Atoms Excited and Ionized by Polarized Electrons.** Dr. A. Kupliauskienė. 2007–2010.

**Development of Methods for the Investigation of Spectral Characteristics of Many-electron Atoms and Their Application for Highly Charged Ions in Thermonuclear and Other Plasmas.** Prof. P. Bogdanovich. 2007–2011.

**Theoretical investigation of plasmas spectra by using collisional-radiative model.** Dr. V. Jonauskas. 2008–2013.

**Investigation of the spectral characteristics of heavy and superheavy elements.** Prof. G. Gaigalas. 2009–2014.

**Investigation of Ionisation in Gas Plasma with Condensed Particles by Mass Spectrometry Method.** Prof. P. Serapinas. 2004–2008.

## **Projects, Programmes, Issues Supported by the Lithuanian State Science and Studies Foundation**

**Lithuanian GRID: Parallel and Distributed Grid for Calculations.** Dr. J. Tamulienė, 2009.

**GridTechno: Investigation of Applicable Problems and Their Realization in Grid Technologies.** Dr. J. Tamulienė, 2009.

**Chemical evolution history of the Large Magellanic Cloud.** Dr. A. Kučinskas. 2009.

**Dynamics and control of slow and stationary polaritons.** Dr. Habil. G. Juzeliūnas. 2009-2011.

**Light Propagation And Storing In Cold Atomic Gases.** Dr. Habil. G. Juzeliūnas. 2008-2010.

## **Projects Supported by the Lithuanian Science Council**

**Multicomponent slow polaritons in cold atomic gases.** Dr. Habil. G. Juzeliūnas. 2009-2011.

## **International Science Programmes and Projects**

FP7 project: *Baltic Grid II*. Habil. Dr. G. Tautvaišienė. 2008–2009.

FP7 project: *Contract of Association EURATOM - Lithuania*. Dr. A. Kupliauskienė. 2008–2009.

FP7 project “**Researchers’ Night in Lithuania 2009**” (**ReNiLit 2009**). Dr. A. Kazlauskas. 2009.

Joint Research Project: *Taiwan-Baltic Theoretical Studies of Spectroscopy of Atoms and Their Behavior in Strong Laser Fields*. Habil. Dr. Z. Rudzikas. 2006–2009.

**COST Action D35. From Molecules to Molecular Devices: Control of Electronic, Photonic, Magnetic and Spintronic Behaviour.** Dr. A. Tamulis. 2005–2010.

**COST Action MP0801. Physics of Competition and Conflicts.** Dr. V. Gontis. 2009-2012.

**COST Action D37. Grid Computing in Chemistry (GRIDCHEM).** Dr. A. Vektarienė. 2007–2010.

**COST Action P19. Multistep modeling of materials. COST Action P19.** Dr. J. Tamulienė. 2005-2010.

Collaboration with Institute for Transuranium Elements of the Joint Research Centre. **Theoretical studies of spectroscopic properties of superheavy atoms and ions with atomic number  $Z=122$ .** Habil. Dr. G. Gaigalas. 2009.

B.Visby project. **Electronic, Transport and Electromagnetic Properties of Graphene Layers and Nanoribbons.** Dr. Habil. G. Juzeliūnas. 2009-2011.

**Coolaboration with CERN.** Dr. E. Norvaišas. 2009.

World Federation of Scientists project. **Calculations of energy corrections with algebraic program MATHEMATICA.** Dr. G. Merkelis. 2009 – 2010.

World Federation of Scientists project. **Astronomy and photometry of close Earth objects.** Dr. K. Černis. 2009 – 2010.

Agreement between France and Lithuania *Žiliberas*. **Light-induced gauge potentials in ultracold atomic gases.** Dr. Habil. G. Juzeliūnas. 2009–2010.

Agreement between Ukraine and Lithuania. **Experimental and theoretical investigation of electron-impact excited complex atoms and molecules.** Dr. A. Kupliauskienė. 2009-2010.

Agreement between Ukraine and Lithuania. **Abundances of light elements and neutron-capture elements in the atmospheres of red giants in globular clusters as probes of stellar evolution and evolution of harbouring clusters.** Dr. A. Kučinskas. 2009-2010.

## **Other Projects**

Long-term international project: **The Whole Earth Telescope.** Dr. R. Janulis, Dr. E. Pakštienė.

Long-term international project: **The European Space Agency Satellite GAIA.** Prof. V. Straižys, Habil. Dr. G. Tautvaišienė, Dr. A. Kazlauskas, Dr. A. Kučinskas.

## **Projects Supported from EU Structural Funds**

**Science for Business and Society.** V. Daniūnas. 2009–2011.

## **MAIN PUBLICATIONS**

### **Articles**

A. Kupliauskienė and V. Tutlys, Properties of Auger electrons following excitation of polarized atoms by polarized electrons // Nuclear Instruments and Methods in Physics Research B, **267**, 263-265 (2009).

A. Kupliauskienė, Fluorescence of polarized atoms excited by polarized electrons // Nuclear Instruments and Methods in Physics Research B, **267**, 266-269 (2009).

- J. G. Li, P. Jonsson, G. Gaigalas, and C. Z. Dong, Hyperfine induced  $1s2s\ ^1S_0 \rightarrow 1s^2\ ^1S_0$  M1 transition of He-like ions // *Eur. Phys. J. D*, (2009).
- G. Gaigalas, E. Gaidamauskas, Z. Rudzikas, N. Magnani, and R. Caciuffo, Theoretical studies of spectroscopic properties of  $\text{Cm}^{4+}$  and  $\text{Am}^{3+}$  // *Phys. Rev. A*, 022511 (2009).
- G. Gaigalas, E. Gaidamauskas, Z. Rudzikas, N. Magnani, and R. Caciuffo. The role of atomic correlations in the theoretical study of minor actinide ions // *J. Nuclear Materials*, 385, 66-67 (2009).
- A. Borovik and A. Kupliauskienė, The  $5p^6$  autoionization cross section of cesium atoms: contribution to single ionization by electron impact // *J. Phys. B: At. Mol. Opt. Phys.* **42**, 165202 (5pp) (2009).
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- R. Karpuškienė and P. Bogdanovich, *Ab initio* oscillator strengths and transition probabilities in aluminium-like calcium, Ca VIII // *Atomic Data and Nuclear Data Tables*, **95**, 533-548 (2009).
- O. Rancova, P. Bogdanovich, and R. Karpuškienė, Quasirelativistic *ab initio* study of Gallium like Molybdenum and Thungsten // *Journal of Physics: Conference Series*, **163**, 012011(4) (2009).
- R. Kisielius, P. J. Storey, G. J. Ferland, and F. P. Keenan, Electron-impact excitation of O II fine-structure levels // *Mon. Not. R. Astron. Soc.* **397**, 903-912 (2009).
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- R. Juršėnas and G. Merkelis, Coupled tensorial form for atomic relativistic two-particle operator given in second quantization representation // *Cent. Eur. J. Phys.*, DOI: 10.2478/s11534-009-0126-5 (2009).
- S. Kučas, R. Karaziya, V. Jonauskas, and A. Momkauskaitė, Interaction of  $4p^5 4d^{N+1}$  and  $4p^5 4d^{N-1} 4f$  configurations and its influence on the photoexcitation and emission spectra in the isoelectronic and isonuclear sequences // *J. Phys. B: At. Mol. Opt. Phys.*, **42**, 205001(10p) (2009).
- Huihui Kang, Jiguang Li, Chenzhong Dong, P. Jonsson, and G. Gaigalas, Hyperfine quenching of the  $3s3p\ ^3P_0$  level in Mg-like ions // *J. Phys. B: At. Mol. Opt. Phys.* **42**, 195002(7pp) (2009).
- P. Bogdanovich, A. Bernotas, and A. Rinkevičius, A universal potential for quasirelativistic radial orbitals // *Lith. J. Phys.*, **49**, 253-260 (2009).
- A. Bernotas and V. Šimonis, Heavy hadron spectroscopy and the bag model // *Lith. J. Phys.* **49**(1), 19 (2009).doi:10.3952/lithjphys.49110
- P. Bogdanovich, V. Jonauskas, R. Karpuškienė, and O. Rancova, Theoretical investigation of x-ray radiation of 4-4 transitions in highly charged tungsten ions, *strapsn* // *Nucl. Instr. and Meth. A* (2009), doi:10.1016/j.nima.2009.10.163.
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- V. Gontis, J. Ruseckas and A. Kononovičius, A long-range memory stochastic model of the return in financial markets // Physica A **389**, p. 100-106 (2010).
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R. Juršėnas and G. Merkelis. Symbolic programming applications for atomic many-body theory. Proceedings of thirteenth international workshop on new approaches to high-tech: nano-design, technology, computer simulations // NDTCS'09 [Elektroninis išteklius]: p. 22-26 (2009).

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Boyle, R., Černis, K.;"Astrometric observations of 2 faint asteroids (11 positions) in the Mount Graham observatory (Code 290)" M.P.C. 66190 (2009 Jun. 7);

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## **COOPERATION**

Vatican Observatory, Institute for Space Observations (USA)

Naval Observatory (USA)

National Central University (Taiwan)

Lund Observatory (Sweden)

National Astronomical Observatory (Japan)

University of Washington (USA)

Universidad de Concepción (Chile)

Geneva Observatory (Switzerland)

l'Observatoire Midi-Pyrénées, Toulouse (France)

Oulu University (Finland)

Uppsala Astronomical Observatory (Sweden)

In the frame of the WET Project, the Astronomical Observatory of the Institute cooperates with astronomical observatories in 15 countries. The partners in atomic, molecular and nuclear physics and quantum optics are from:

Queen's University, Belfast (UK)

University of Strathclyde (UK)

Culham Science Centre (UK)

Institute of Metal Physics of RAS Ekaterinburg (Russia)

Institute of Electron Physics (Ukraine)

Saskatchewan University (Canada)

Kassel University (Germany)

Institute of Molecular Physics, Poznan (Poland)

University of East Anglia, Norwich (UK)

National Institute of Chemistry, Ljubljana (Slovenia) and other institutions

Institute for Transuranium Elements of the Joint Research Centre (Germany)

### ***OTHER SCIENTIFIC ACTIVITIES***

#### **Prof. V. Straizys –**

- editor-in-chief of the international journal *Baltic Astronomy*.

#### **Prof. R. Karazija –**

- editor-in-chief of the journal *Lithuanian Journal of Physics*.

#### **Prof. B. Kaulakys –**

- editorial board member of the journal *Lithuanian Journal of Physics*.
- editorial board member of the journal *Nonlinear Analysis: Modelling and Control*

#### **Prof. A. Bartkevičius, dr. A. Kupliauskienė –**

- experts of the Lithuanian State Science and Studies Foundation.

#### **Prof. V. Straizys, Habil. Dr. G. Tautvaišienė, Dr. A. Kazlauskas, Dr. A. Kučinskas –**

- members of working groups of the GAIA space mission, European Space Agency.

#### **Habil. Dr. G. Tautvaišienė –**

- member of the executive committee at the Commission of Stellar Atmospheres of the International Astronomical Union;
- member of the C19 (astrophysics) Commission of IUPAP.

#### **Prof. Z. Rudzikas –**

- member of the executive committee of the European Physical Society;
- member of the board of Governors of EU Joint Research Centre;
- member of the EU European Economic Social Committee