Institute of Theoretical Physics and Astronomy

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Director - Dr. Habil. *Gediminas Juzeliūnas*

STAFF

62 research fellows (49 holding research degree), 8 doctoral students. Full staff comprises 86 people.

DEPARTMENTS OF THE INSTITUTE

Astronomical Observatory

Department of the Theory of Atom

Department of the Theory of Nucleus

Department of the Theory of Processes and Structures

Planetarium

RESEARCH AREAS

Analysis of Atoms, Subatomic Particles or their Ensembles, Complex Systems, Electromagnetic Radiation and Cosmic Objects.

DOCTORAL DISSERTATIONS MAINTAINED IN 2016

V. Čepas. Galactic structure and star formation in the vicinity of H II region SH2-205.
A. Drazdauskas. Evolutionary carbon and nitrogen abundance alterations in low mass metal-abundant stars.

MAIN CONFERENCES ORGANIZED IN 2016

From Star and Planet Formation to Early Life, April 25 – 28 , 2016, Vilnius.

MAIN SCIENTIFIC ACHIEVEMENTS IN 2016

Calculations of three-body nuclear reactions including the core excitation and studies of SO(10) model, reducing the number of Yukawa constants by imposing abelian and nonabelian symmetries.

Electron-impact ionization cross sections for the ground level of the W^{25+} ion have been investigated by performing level-to-level calculations. The obtained results demonstrate that excitations to the high-*nl* shells ($n \geq 9$) increase cross sections of the indirect ionization process by about 60% compared to the excitations to the lower shells ($n \leq 8$). It was established that excitations to the shells with the orbital quantum number $l = 4$ gave the greatest contribution to the excitation-autoionization process.

Evidences of a separate evolution of the metal-poor thin disk discovered, probes of Galactic inner disk abundance gradients provided, evidences presented on the form of the Galactic bulge, implications of stellar and Galactic evolution of sodium and aluminium abundances uncovered, 3D hydrodynamical model atmosphere analysis showed a possibility to derive precise oxygen abundances from ultraviolet OH lines for metal-poor stars, it was determined that hydrogen lines directly traced stellar mass.

Nonlinear stochastic differential equations as source of 1/f noise have been generalized by proposing a system of two coupled nonlinear stochastic differential equations. The coupled equations can generate signal with 1/f spectrum in a wide range of frequencies together with the almost arbitrary steady-state density of the signal. A distinction between the internal time of the system and the physical time has been suggested as a source of 1/f noise. It has been shown that the relation between the internal time and the physical time that depends on the intensity of the signal can lead to 1/f spectrum.

ASTRONOMICAL OBSERVATORY

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Head – Dr. Habil. *Gražina Tautvaišienė*

STAFF

Chief Research fellows: Dr. Habil. G. Tautvaišienė, Dr. K. Černis, Dr. A. Kučinskas, Prof. Emeritus Dr. Habil. V. Straižys, Prof. Dr. Habil. A. Bartkevičius (affiliated), Dr. Habil. K. Zdanavičius (affiliated).

Senior Research fellows: Dr. R. Janulis, Dr. A. Kazlauskas, Dr. E. Pakštienė, Dr. J. Zdanavičius.

Research fellows: Dr. Y. Chorniy, Dr. V. Dobrovolskas, Dr. M. Maskoliūnas, Dr. Š. Mikolaitis, Dr. E. Puzeras, Dr. E. Stonkutė, Dr. R. Ženovienė.

Junior Research fellows: G. Barisevičius (part time), V. Čepas (part-time), A. Černiauskas, A. Drazdauskas, J. Klevas, M. Macijauskas, K. Milašius (part-time), D. Prakapavičius.

Doctoral students: A. Černiauskas, A. Drazdauskas, J. Klevas, E. Kolomniecas,

M. Macijauskas, K. Milašius, Ž. Misikonytė.

Lecturer: S. Lovčikas.

Engineer: G. Valiauga.

Technicians: V. Bagdonas (part-time), L. Klebonas (part-time).

Administrator: V. Kakarienė.

Manager: R. Mikutavičienė.

RESEARCH INTERESTS

Galactic structure and chemodynamical evolution

Stellar photometry and classification

Interstellar reddening and extinction

Chemical analysis of stellar atmospheres, mixing in stellar atmospheres

Hydrodynamical phenomena and non-equilibrium radiative transfer in stellar atmospheres

Stellar asteroseismology

Planet hosting stars and exoplanet transits

Search and positional observations of comets and asteroids

RESEARCH PROJECTS CARRIED OUT IN 2016

Projects Supported by University Budget

Stellar chemical composition and asteroseismic activity in the Milky Way Galaxy. Dr. Habil. G. Tautvaišienė. 2016–2020.

Solutions for the origin of Li-rich giants were proposed. The Li-rich phenomenon may occur during the tidal destruction of close-in hot Jupiters at the sub-giant phase. When coupled with models of planet accretion, the observed destruction of hot Jupiters predicts the existence of Li-rich giant stars, and suggests Li-rich stars should be found early on the giant branch and occur more frequently with increasing metallicity. We also accomplished a detailed analysis of lithium extra-mixing in stars of the open cluster Trumpler 20. Within the AMBRE project collaboration we continued the chemical analysis of Galactic substructures and lithium distribution in the Galaxy, in particular.

Main publications:

Casey, A. R.; Ruchti, G.; Masseron, T.; Randich, S.; Gilmore, G.; Lind, K.; Kennedy, G. M.; Koposov, S. E.; Hourihane, A.; Franciosini, E.; Lewis, J. R.; Magrini, L.; Morbidelli, L.; Sacco, G. G.; Worley, C. C.; Feltzing, S.; Jeffries, R. D.; Vallenari, A.; Bensby, T.; Bragaglia, A.; Flaccomio, E.; Francois, P.; Korn, A. J.; Lanzafame, A.; Pancino, E.; Recio-Blanco, A.; Smiljanic, R.; Carraro, G.; Costado, M. T.; Damiani, F.; Donati, P.; Frasca, A.; Jofré, P.; Lardo, C.; de Laverny, P.; Monaco, L.; Prisinzano, L.; Sbordone, L.; Sousa, S. G.; Tautvaišienė, G.; Zaggia, S.; Zwitter, T.; Delgado Mena, E.; Chorniy, Y.; Martell, S. L.; Silva Aguirre, V.; Miglio, A.; Chiappini, C.; Montalban, J.; Morel, T.; Valentini, M., 2016 The Gaia-ESO Survey: revisiting the Li-rich giant problem // Monthly Notices of the Royal Astronomical Society, Volume 461, Issue 3, p.3336-3352.

Smiljanic, R.; Franciosini, E.; Randich, S.; Magrini, L.; Bragaglia, A.; Pasquini, L.; Vallenari, A.; Tautvaišienė, G.; Biazzo, K.; Frasca, A.; Donati, P.; Delgado Mena, E.; Casey, A. R.; Geisler, D.; Villanova, S.; Tang, B.; Sousa, S. G.; Gilmore, G.; Bensby, T.; François, P.; Koposov, S. E.; Lanzafame, A. C.; Pancino, E.; Recio-Blanco, A.; Costado, M. T.; Hourihane, A.; Lardo, C.; de Laverny, P.; Lewis, J.; Monaco, L.; Morbidelli, L.; Sacco, G. G.; Worley, C. C.; Zaggia, S.; Martell, S., 2016, The Gaia-ESO Survey: Inhibited extra mixing in two giants of the open cluster Trumpler 20? // Astronomy & Astrophysics, Volume 591, id.A62.

G. Guiglion, P. de Laverny, A. Recio-Blanco, C. C. Worley, M. De Pascale, T. Masseron, N. Prantzos, and Š. Mikolaitis: The AMBRE project: Constraining the lithium evolution in the Milky Way, Astronomy and Astrophysics, 595, A18, (2016)

Star formation and dust clouds in the Orion and Perseus arms of the Galaxy. Prof. V. Straižys. 2016–2020.

Interstellar extinction in the direction of dark clouds TGU H942 P7, TGU H942 P8, Dobashi 4040 and Dobashi 4042, located within the dust ring at the Camelopardalis and Perseus border, was investigated using about 1600 stars observed in the seven-colour Vilnius system and the 2MASS and WISE infrared photometric systems. Spectral and luminosity classes, interstellar reddenings and distances were determined. 88 young stellar objects have been discovered. In the area of young open cluster NGC 2264 a general catalogue of young stellar objects has been compilel containing about 600 objects.

Main publications:

V Straižys, V. Čepas, R. P. Boyle, J. Zdanavičius, M. Maskoliūnas, A. Kazlauskas, K. Zdanavičius, J. The dark cloud TGU H994 P1 (LDN 1399, LDN 1400, and LDN 1402): Interstellar extinction and distance“, Astronomy and Astrophysics, 585, A31, (2016).

Straižys, V., Čepas, V., Boyle, R. P., Zdanavičius, J., Maskoliūnas, M., Kazlauskas, A., Zdanavičius, K. and Černis, K. Dark clouds in the vicinity of the emission nebula Sh2-205: interstellar extinction and distances, Astronomy and Astrophysics, vol. 590, A21 (2016).

Hydrodynamical phenomena and radiative transfer in stellar atmospheres. Dr. A. Kučinskas. 2015–2019.

An in-depth study of the formation of OH UV spectral lines in the atmosphere of a metal-poor red giant star HD 122563 was carried out using 3D hydrodynamical CO^5BOLD model atmosphere. Oxygen abundances obtained using 3D hydrodynamical model atmosphere and different oxygen abundance indicators (OH UV & IR lines, the forbidden [O I] line) are more accurate and reliable than those determined using classical 1D hydrostatic model atmospheres. Inclusion of chromospheric layers in the model is very important for reproducing accurate formation of strong low-excitation OH UV lines.

Main publications:

Prakapavičius, D., Kučinskas, A., Dobrovolskas, V., Klevas, J., Steffen, M., Bonifacio, P., Ludwig, H.-G., Spite, M.2016. Three-dimensional hydrodynamical CO5BOLD model atmospheres of red giant stars. V. Oxygen abundance in the metal-poor giant HD 122563 from OH UV lines, Astronomy & Astrophysics, in press, DOI: http://dx.doi.org/10.1051/0004-6361/201629306 (2017).

Astrometry and photometry of small Solar-system bodies. Dr. K. Černis. 2016–2020.

Eleven new asteroids have been discovered. New precise orbits were determined for our earlier discovered 43 objects at the Baldone Observatory. We published 3511 astrometric positions of 826 asteroids. Near Earth Objects, TNO, Main Belt, Centaurs asteroids and comets were observed with 0.35/0.51 m Maksutov telescope (Molėtai Observatory, Lithuania), with 0.80/1.20 m Schmidt telescope (Baldone Observatory, Latvia) and with 1.8 m Vatican telescope (Mt. Graham, Arizona, U.S.A.). Four asteroids were named by Kęstutis, Juzeliūnas, Lazauskaitė, and Marijampolė.

Main publications:

Černis, K., Boyle, R. P., Wlodarczyk, I. Discovery, observational data and the orbit of transneptunian object (420356) Praamžius. Baltic Astronomy, 25, 189-194, 2016.

Černis, K., Wlodarczyk, I., Zdanavičius J. Orbits of asteroids discovered at the Molėtai observatory in 2005-2007. Baltic Astronomy, 25, 165-178, 2016.

Černis, K., Wlodarczyk, I., Zdanavičius J. Orbits of asteroids discovered at the Molėtai observatory in 2008-2009. Baltic Astronomy 25, 447-459, 2016.

National Research Projects

Research Council of Lithuania. **Spectroscopic and Photometric Survey of Northern Sky for the ESA PLATO space mission** (LAT-16019). Dr. Š. Mikolaitis. 2016 – 2018.

The ESA-PLATO 2.0 mission will be searching for extraterrestrial telluric-like planets. The main objective of the scientific preparation is to create a most promising input catalogue of targets. The largest spectroscopic surveys are mostly performed from the southern hemisphere and do not contain the brightest objects in their star-lists. This adds a significant importance to the equipment operated at our Observatory. Our objective is to prepare the dataset of the brightest targets of the most-northern regions of the sky-sphere for the northern PLATO 2.0 fields employing our spectroscopic and photometric instruments, taking advantage of their northern geographical location. We composed a list of targets to be be analyzed before the launch of the space mission. We already observed high-resolution (R = 60 000) spectra of 160 FGK stars in the STEP02 PLATO field during the first 8 months of the project. We have monitored 19 segments in several northern PLATO fields and discovered around 20 previously unknown variable stars. Preliminary results were presented at two international conferences.

Research Council of Lithuania. **Towards realistic stellar model atmospheres: magnetic fields, molecules, and non-equilibrium radiative transfer in stellar atmospheres** (MIP–089/2015). Dr. A. Kučinskas. 2015 – 2018.

Analysis of the 3D hydrodynamical model atmosphere of a red giant star with the atmospheric parameters similar to those of Aldebaran has shown that shock waves propagating in its chromosphere alter the intensity and shape of the chromospheric spectral line profiles, and lead to a significantly higher UV flux. It is impossible to recover these properties using classical 1D hydrostatic model atmospheres. The obtained results demonstrate that the use of 3D hydrodynamical models is essential in the abundance analysis based on strong spectral lines that form in the outer parts of stellar atmospheres.

Main publications:

S. Wedemeyer, A. Kučinskas, J. Klevas, H.-G. Ludwig, Three-dimensional hydrodynamical CO5BOLD model atmospheres of red giant stars VI. First chromosphere model of a late-type giant, Astronomy & Astrophysics, submitted

A. Černiauskas, A. Kučinskas, J. Klevas, D. Prakapavičius, S. Korotin, P. Bonifacio, H.-G. Ludwig, E. Caffau, M. Steffen, Abundances of Na, Mg, and K in the atmospheres of RGB stars of Galactic globular cluster 47 Tucanae, Astronomy & Astrophysics, submitted

Research Council of Lithuania. **Spectroscopic survey of carbon, nitrogen and oxygen in stars of the Galactic open clusters** (MIP-082/2015). Dr. Habil. G. Tautvaišienė. 2015 – 2018.

Using high-resolution spectra we have investigated 16 open clusters. The results of carbon and nitrogen abundances show that carbon isotope ratios for stars with turn-off masses lower than 1.5 M_{Sun} can be explained with the model that includes pure thermohaline-induced mixing as well as with the model of thermohaline and rotation-induced mixing acting together. For larger turn-off masses the first dredge-up or the pure thermohaline-induced mixing is preferred. When looking at the C/N ratio, for stars with masses up to about 3 M_{Sun} the first dredge-up or the pure thermohaline-induced mixing models reproduce the results better, however for larger turn-off masses our results agree better with the model which includes both thermohaline- and rotation-induced mixing, but within errors agree with the first dredge-up model as well.

Main publications:

Drazdauskas, A., Tautvaišienė, G., Smiljanic, R., Bagdonas, V., Chorniy, Y., Chemical composition of evolved stars in the young open clusters NGC 4609 and NGC 5316 // Monthly Notices of the Royal Astronomical Society, Volume 462, Issue 1, p.794-803, 2016.

Tautvaišienė, G., Drazdauskas, A., Bragaglia, A., Randich, S., Ženovienė, R., CNO abundances and carbon isotope ratios in evolved stars of the open clusters NGC 2324, NGC 2477, and NGC 3960 // Astronomy & Astrophysics, Volume 595, id.A16, 2016.

Drazdauskas, A.; Tautvaišienė, G.; Randich, S.; Bragaglia, A.; Mikolaitis, Š.; Janulis, R., The extent of mixing in stellar interiors: the open clusters Collinder 261 and Melotte 66 // Astronomy & Astrophysics, Volume 589, id.A50, 2016.

International Research Projects

International programme **Gaia-ESO Spectroscopic Survey** (ESO project 188.B-3002). Dr. Habil. G. Tautvaišienė. 2012 – 2017.

The main results of this project co-authored by the Vilnius astronomers in 2016: evidences of a separate evolution of the metal-poor thin disk discovered, probes of Galactic inner disk abundance gradients provided, the selection function of the Galactic field stars evaluated, it was determined that hydrogen lines directly trace stellar mass, evidences provided on the form of the Galactic bulge, implications of stellar and Galactic evolution of sodium and aluminium abundances uncovered, etc.

Main publications:

Rojas-Arriagada, A.; Recio-Blanco, A.; de Laverny, P.; Schultheis, M.; Guiglion, G.; Mikolaitis, Š.; Kordopatis, G.; Hill, V.; Gilmore, G.; Randich, S.; Alfaro, E. J.; Bensby, T.; Koposov, S. E.; Costado, M. T.; Franciosini, E.; Hourihane, A.; Jofré, P.; Lardo, C.; Lewis, J.; Lind, K.; Magrini, L.; Monaco, L.; Morbidelli, L.; Sacco, G. G.; Worley, C. C.; Zaggia, S.; Chiappini, C., 2016, The Gaia-ESO Survey: Separating disk chemical substructures with cluster models. Evidence of a separate evolution in the metal-poor thin disk // Astronomy & Astrophysics, Volume 586, id.A39.

Jacobson, H. R.; Friel, E. D.; Jílková, L.; Magrini, L.; Bragaglia, A.; Vallenari, A.; Tosi, M.; Randich, S.; Donati, P.; Cantat-Gaudin, T.; Sordo, R.; Smiljanic, R.; Overbeek, J. C.; Carraro, G.; Tautvaišienė, G.; San Roman, I.; Villanova, S.; Geisler, D.; Muñoz, C.; Jiménez-Esteban, F.; Tang, B.; Gilmore, G.; Alfaro, E. J.; Bensby, T.; Flaccomio, E.; Koposov, S. E.; Korn, A. J.; Pancino, E.; Recio-Blanco, A.; Casey, A. R.; Costado, M. T.; Franciosini, E.; Heiter, U.; Hill, V.; Hourihane, A.; Lardo, C.; de Laverny, P.; Lewis, J.; Monaco, L.; Morbidelli, L.; Sacco, G. G.; Sousa, S. G.; Worley, C. C.; Zaggia, S., 2016, The Gaia-ESO Survey: Probes of the inner disk abundance gradient // Astronomy & Astrophysics, Volume 591, id.A37.

Stonkutė, E.; Koposov, S. E.; Howes, L. M.; Feltzing, S.; Worley, C. C.; Gilmore, G.; Ruchti, G. R.; Kordopatis, G.; Randich, S.; Zwitter, T.; Bensby, T.; Bragaglia, A.; Smiljanic, R.; Costado, M. T.; Tautvaišienė, G.; Casey, A. R.; Korn, A. J.; Lanzafame, A. C.; Pancino, E.; Franciosini, E.; Hourihane, A.; Jofré, P.; Lardo, C.; Lewis, J.; Magrini, L.; Monaco, L.; Morbidelli, L.; Sacco, G. G.; Sbordone, L., 2016, The Gaia-ESO Survey: the selection function of the Milky Way field stars // Monthly Notices of the Royal Astronomical Society, Volume 460, Issue 1, p.1131-1146.

Long-term international project **The European Space Agency Satellite Gaia**. Prof. V. Straižys, Dr. Habil. G. Tautvaišienė.

The first results of the Gaia Space Mission, launched in December of 2013, have been published in 2016 with co-authorship of V. Straižys. For a few years V. Straižys was the manager of two working groups (Interstellar extinction and Peculiar stars) of the Gaia project. Together with A.G.A. Brown, R. Lazauskaitė and K. Zdanavičius he developed a method for empirical decontamination of the Gaia BP/RP low-dispersion spectra and their application for photometric classification of stars.

Main publications:

Gaia Collaboration: Brown, A. G. A.; Vallenari, A.; Prusti, T.; …; Straižys, V.; …, Gaia Data Release 1. Summary of the astrometric, photometric, and survey properties // Astronomy & Astrophysics, Volume 595, id.A2, (2016).

Gaia Collaboration: Prusti, T.; de Bruijne, J. H. J.; Brown, A. G. A.; Vallenari, A.; …; Straižys, V.; …, The Gaia mission // Astronomy & Astrophysics, Volume 595, id.A1, (2016).

EC Horizon2020 project "**EUROPLANET2020 – Research Infrastructure**" (project No. 654208). Dr. Habil. G. Tautvaišienė. 2015 – 2019.

Researchers of the Vilnius University were working in the work packages dedicated to on-ground observations, coordination and training of amateur astronomers and planeary science outreachers. Europlanet NA1-Task 5 Summer School "Exoplanets" took place on 2 – 12

August 2016 at the Moletai Astronomical Observatory of Vilnius University.The aim of the school was to give participants a thorough multidisciplinary introduction into the field of exoplanets, their detection, types, characterization, formation of planetary systems, habitability of planets, and physical processes in planetary atmospheres. To give participants some hands-on experience with detection of exoplanets, observations of several exoplanet transits using the Molėtai Observatory telescopes and remotely the SONG telescope at the Teide Observatory in Canary Islands were carried out. The course was atended by 33 PhD and master students, early career scientists, and amateur astronomers.

ERASMUS+ Strategic Partnerships project "**European Astrobiology Capus**" (project No. 2014-1-EE01-KA203-000518). Dr. Habil. G. Tautvaišienė. 2014 – 2017.

The Summer School "Exoplanets", which took place on 2 – 12 August 2016 at the Moletai Astronomical Observatory of Vilnius University, included also activities foreseen in this project. Questions of formation of exoplanets and habitability were covered by the outstanding scientists such as prof. Hans Kjeldsen from Aarhus University who is among the leaders of the Keppler, TESS, and PLATO space missions of exoplanet research, an author of almost 500 papers cited more than 10 000 times, as well as Dr. Madhusudhan Nikku from Cambridge University who is a most cited scientist in the field of research of exoplanet atmospheres in the world.

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

We participated in two WET campaigns in 2016: (1) 23rd May – 21st June, time series photometry of the central star of the planetary nebula PN Abell 43 at the Molėtai Astronomical Observatory; (2) 18 – 31 October at the Molėtai AO, and on the 1st and 2nd of November at the Nordic Optical Telescope (NOT) in La Palma (Canary Islands), time series photometry of the central star of the planetary nebula PN NGC 1501. At the Molėtai AO we observed with the 1.65 m telescope and CCD camera Alta U47, and in La Palma with the Nordic Optical Telescope and ALFOSC CCD photometer.

International long-term international project **Kepler Follow-up Program of Kepler Objects of Interest (KFOP-KOIs).** Dr. E. Pakštienė, Dr. R. Janulis. Since 2016.

In 2016 we started to participate in the Kepler Follow-up Program which is initiated to conduct follow-up observations of Kepler Objects of Interest (KOIs). KOIs are well vetted, periodic, transit-like events in the Kepler data. The aim of the Kepler Follow up Program of KOIs is looking for the Transit Timing Variation and the Transit Duration Variation (TTV/TDV), which indication to more than one exoplanet in a planetary system. Our coordinated observations will be carried out at the Molėtai Astronomical Observatory.

International long-term project **Gaia Science Alerts**. Dr. E. Pakštienė, Dr. R. Janulis. Since 2016.

The Gaia Science Alerts Working Group is focussed on the real-time detection of variable sources. These include supernovae, microlensing events, exploding and eruptive stars, etc. More than 50 ground-based observatories (scientific and amateur) participate in this project.

In 2016, the Molėtai Astronomical Observatory has started to participate in the working group GSAWG10 (Photometric Follow-Up) activities of this project. The binary microlensing object *gaia16aye* was observed at the Molėtai AO with the 1.65 m telescope and CCD camera Alta U47 for three nights in October of 2016. The first results were presented at the 7th OPTICON Gaia Science Alerts workshop in Utrecht, Netherlands, 7-9 Dec 2016.

International project **BRITE-Constellation**. Dr. E. Pakštienė, Dr. Š. Mikolaitis. Since 2016.

BRITE (BRIght Target Explorer) Constellation is a network aiming to investigate stellar structure and evolution of brightest stars in the sky and their interaction with the local environment. Micropulsation, wind phenomena, and other forms of stellar variability are recorded via high precision photometry. The massive BRITE target stars are extremely important in producing chemical elements and recycling them in winds and supernovae. The Molėtai Observatory started to participate in this project in 2016 performing ground-based follow-up observations of BRITE objects. Five high-resolution spectra of the bright multiple star *Epsilon Persei* were obtained with the 1.65 m telescope and VUES spectrograph. Gerald Handler from Nicolaus Copernicus Astronomical Centre in Warsaw visited our institute with a presentation of the BRITE project.

COST Action TD1308 **„Origins and evolution of life on Earth and in the Universe"** (ORIGINS) (http://www.cost.eu/COST_Actions/tdp/TD1308). Action Chair: Prof. Muriel Gargaud, France) (29 countries). Dr. habil. G. Tautvaišienė. 2014 – 2018.

A COST funded international conference "From star and planet formation to early Life" was organized in Vilnius on 25 – 28 April 2016. The conference covered a multitude of scientific subjects ranging from star and planet formation until the early evolution of life on the Earth. It brought together about 150 astronomers, physicists, chemists, geologists and biologists to discuss the most important questions and the newest findings in all related disciplines. Special sessions were devoted to comets, meteorites, prebiotic chemistry and early life (http://www.vilnius2016.eu).

Long-term international project **Researchers' Night 2016/2017** (LT-2016). I. Balčiūnienė (VU), Dr. A. Kazlauskas (ITPA). 2016 – 2017.

The main purpose of this project is the meeting of scientists with general public. Such meetings took place on the 30th of September at the Molėtai Astronomical Observatory as well as in hundreds of other science institutions in Europe. It is a Europe-wide public event dedicated to popular science. More than 30 countries and over 300 cities are involved. The Moletai Astronomical Observatory programme included 16 lectures given by eight lecturers, tours to professional telescopes, stargazing, science videos. Almost all staff of the Observatory and several scientists from some other departments have met with 400 people visiting the Observatory.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INOVATION) PARTNERS

Astrophysical Institute Potsdam (Germany)

Copenhagen University (Denmark)

Kiepenheuer Institut fur Sonnenphysik (Germany)

Landessternwarte – Zentrum für Astronomie der Universität Heidelberg (Germany)

Observatoire de Paris, CNRS, Université Paris Diderot (France)

Vatican Observatory (USA)

Washington University (USA)

OTHER SCIENTIFIC ACTIVITIES

Dr. K. Černis –

- member of the Lithuanian Astronomical Olympiad Council;
- member of the International Astronomical Union (IAU).

Dr. A. Kučinskas –

- member of the Board of Directors of the International journal Astronomy and Astrophysics;
- vicepresident, Lithuanian Astronomical Society;
- member of the International Astronomical Union.

Dr. Š. Mikolaitis –

- Chair od the Local organising committee of the International conference "From star and planet formation to early Life", Vilnius, 25 – 28 April 2016.

Prof. V. Straižys –

- editor-in-chief of the International journal *Baltic Astronomy*;
- member emeritus of the Lithuanian Academy of Sciences;
- member of the working group on stellar classification of the ESA Gaia project;
- member of the International Astronomical Union;
- member of the European Astronomical Society.

Dr. Habil. G. Tautvaišienė –

- vicepresident of the International Union of Pure and Applied Physics;
- vicepresident of the Lithuanian Physics Society;
- chair of Astrophysics Commission at the International Union of Pure and Applied Physics;
- member of the International Astronomical Union (IAU);
- executive board member of the International *Astronet* project;
- founding member of the European Astronomical Society;

- editorial board member of the journal *Baltic Astronomy*;
- editor-in-chief of the annual astronomical almanac *Lietuvos dangus* (*Sky of Lithuania*);
- Chair of the Scientific organizing committee of the international conference "From star and planet formation to early Life", Vilnius, 25 – 28 April 2016.

DEPARTMENT OF THE THEORY OF ATOM

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Head – Dr. *Valdas Jonauskas*

STAFF

Chief research fellows: Prof. Dr. Habil. P. Bogdanovičius (part-time), Prof. Dr. Habil. G. Gaigalas, Prof. Dr. Habil. R. Karazija (affiliated), Doc. Dr. V. Jonauskas, Dr. A. Kupliauskienė (part-time).

Senior research fellows: Dr. R. Karpuškienė, Dr. J. Tamulienė, Dr. R. Kisielius, Dr. S. Kučas, Dr. G. Merkelis.

Research fellows: Doc. Dr. A. Kynienė, Dr. A. Momkauskaitė, Dr. R. Juršėnas, Dr. Š. Masys, Dr. P. Rynkun.

Junior research fellows: L. Radžiūtė, G. Kerevičius (part-time).

Technicians: J. Koncevičiūtė (part-time), S. Pakalka (part-time).

Doctoral student: G. Kerevičius, L. Radžiūtė, J. Koncevičiūtė, S. Pakalka.

RESEARCH INTERESTS

Theoretical atomic spectroscopy

Methods of the theory of complex atomic and ionic spectra

Development of quantum many-body theory

Development and application of algorithms and computer programs for plasma physics, astrophysics and other fields

Development of quantum mechanics and quantum electrodynamics for the transitions in atoms, molecules and molecular complexes

Investigation of the processes of interaction of atoms with electrons and radiation

Modelling of contemporary atomic theory problems based on usual and symbolic programming

Investigation of the spectroscopic characteristics of the molecular compounds

Theoretical investigation of crystalline and electronic structure of perovskite crystals

RESEARCH PROJECTS CARRIED OUT IN 2016

Projects Supported by University Budget

Investigation of the spectroscopic characteristics of complex atoms and their derivatives. Dr. A. Kupliauskienė. 2012–2017.

Outermost filled subshell states of Ba and Sr atoms excited by electron-impact are investigated. In the case of quasirelativistic approximation the velocity form of the electric dipole transition operator is derived. The spectroscopic characteristics for some configurations of W XXXIV, Fe V, Co VI and Ni VII are analyzed in quasirelativistic approximation. The cases of the creation of different fragments of valine in various chemical reactions are determined. The existence of nonempty set for p(t) homogeneous operator is shown.

Main publications:

V. Hrytsko, G. Kerevičius, A. Kupliauskienė, A. Borovik. The 5p autoionization spectra of Ba atoms excited by electron impact: identification of lines. J. Phys. B: At. Mol. Opt. Phys. 49, 145201 (2016).

R. Juršėnas. Spectrum of a family of spin-orbit coupled Hamiltonians with singular perturbation. J. Phys. A: Math. Theor. 49, 065202 (2016).

J. Tamulienė, L. Romanova, V. Vukstich, A. Papp, S. Shkurin, L. Baliulytė, A. Snegursky. On the influence of low-energy ionizing radiation on the amino acid molecule: proline. Eur. Phys. J. D 70:143 (2016).

Investigation of ordered and unordered atomic systems. Dr. V. Jonauskas. 2014–2018.

Electron-impact direct double ionization of the ground-state Li+ ion is investigated. Electron-impact ionization cross sections for the ground level of the W25+ ion have been studied by performing level-to-level calculations and using the Dirac-Fock-Slater method. Experimental and theoretical studies for innershell photoionization of neutral atomic nitrogen for photon energies of 403 − 475 eV are presented. The structural parameters of orthorhombic SrRuO3 have been optimized and compared to the experimental data, thereby allowing to select the most suitable DFT approximations for the study of only recently stabilized phases of this perovskite crystal.

Main publications:

A. Kynienė, S. Pakalka, Š. Masys, V. Jonauskas. Electron-impact ionization of W25+. J. Phys. B: At. Mol. Opt. Phys. **49**, 185001 (2016).

Š. Masys, V. Jonauskas. On the crystalline structure of orthorhombic SrRuO3: a benchmark study of DFT functionals. Comput. Mater. Sci. **124**, 78 (2016).

K.M. Aggarwal, P. Bogdanovich, F.P. Keenan, R. Kisielius. Energy levels and radiative rates for Cr-like Cu VI and Zn VII. Atomic Data Nucl. Data Tables **111-112**, 280 (2016).

Correlaton and relativistic effects in complex atoms and ions. Prof. G. Gaigalas. 2015–2019.

Multiconfiguration Dirac-Hartree-Fock (MCDHF) calculations and relativistic configuration interaction (RCI) calculations are performed for states of the $3s^23p^2$, $3s3p^3$ and $3s^23p3d$ configurations in the Si-like ions Ti IX – Ge XIX, Sr XXV, Zr XXVII and Mo XXIX. Valence and core-valence electron correlation effects are accounted for through large configuration state function expansions. Calculated energy levels are compared with the data from other calculations and with the experimental data from the reference databases. Lifetime and transition rates along with uncertainty estimations are given for all ions. Energies from the calculations are in excellent agreement with observations and computed wavelengths are almost of spectroscopic accuracy, aiding line identification in spectra.

Main publications:

C. Froese Fischer, M.R. Godefroid, T. Brage, P. Jönsson, and G. Gaigalas, Topical Review; Advanced multiconfiguration methods for complex atoms: I Energies and wave functions *Journal of Physics B, Atomic Molecular and Optical Physics*. **49**, 182004 (2016).

L. Radžiūtė, G. Gaigalas, P. Jönsson, and J. Bieron, Electric dipole moments of superheavy elements: A case study on copernicium // *Physical Review A, Atomic, molecular, and optical physics*. **93**, 062508 (2016).

C.F. Fischer, I.P. Grant, G. Gaigalas, P. Rynkun, *Lifetimes of some* $2s^23p\ ^2P_{3/2}$ *states from variational theory,* Physical Review A, Atomic, molecular, and optical physics., **93**, 022505 (2016).

International Research Projects

COST Action TA1201 „Gender, Science, Technology and Environment (genderSTE)" (https://e-services.cost.eu/action/TA1201/overview) (2012-2016), Action Chair: Prof. Ines Sanchez de Madariaga, (Spain), 33 countries. Doc. Dr. D. Šatkovskienė.

Participation in the work group „Promoting Structural and institutional change" and organization of the Meeting „Capacity Building Symposium for Policy Makers" in Vilnius (April 4-5, 2016).

COST action MP1208 „Developing the Physics and the Scientific community for Inertial Confinement Fusion at the time of NIF ignition" (2013 – 2017). Action Chair: Prof. Dimitri Batani (France), 18 countries. Prof. Dr. Habil. P. Bogdanovičius

During year 2016, there were arranged several internet votes on various subjects of action.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INOVATION) PARTNERS

National Institute of Standards and Technology (USA)

University of Kentucky, Lexington (USA)

Materials Science and Applied Mathematics, Malmö University, Malmö (Sweden)

Chimie Quantique et Photophysique, Université Libre de Bruxelles (Belgium)

National Institute for Fusion Science (Japan)

Cracow Jagiellonian University (Poland)

OTHER SCIENTIFIC ACTIVITIES

Prof. P. Bogdanovičius

- head of Lithuanian Physics' Olympiad Team.

Prof. G. Gaigalas, dr. P. Rynkun, and L. Radžiūtė

member of CompAS (The International collaboration on Computational Atomic Structure) group (http://ddwap.mah.se/tsjoek/compas/)

Prof. R. Karazija –

- editorial board member of the Lithuanian Journal of Physics;
- member of the Lithuanian Academy of Sciences.

Dr. A. Kynienė –

- president of the Vilnius City Board of the Physics Teachers' Association;
- member of Vilnius City Physics Methodical Board.

Dr. A. Kupliauskienė –

- head of the board of Association "BASNET Forumas" (http://www.basnetforumas.eu /index.php?option=com_content&view=frontpage&lang=en)

Dr. J. Tamulienė –

- management committee member of the Lithuanian Physics Society;
- leader of the Professional Union of Vilnius University.

DEPARTMENT OF THE THEORY OF NUCLEUS

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Senior Researchers: Doc. Dr. A. Acus, Dr. A. Juodagalvis, Dr. T. Gajdosik, Prof. Dr.(HP) E. Norvaišas.

Researchers: Dr. D. Jurčiukonis, Dr. V. Šimonis.

Engineers: V. Dūdėnas, V. Mickus.

Technician: S. Draukšas.

RESEARCH INTERESTS

Development of algebraic techniques for nuclear and particle physics
Investigation of symmetries in nuclear and particle physics
Development of topological soliton model
Investigation of electroweak vector bosons in pp collisions
Investigation of scattering processes in few-body nuclear systems

RESEARCH PROJECTS CARRIED OUT IN 2016

Project Supported by University Budget

Theoretical Study of Light Nuclei and Elementary Particles. Dr. A. Deltuva. 2016–2020.

Elastic scattering and three-cluster breakup in intermediate-energy deuteron-deuteron collisions were calculated using the first term in the Neumann series expansion for transition operators. Universal properties of the three- and four boson systems near the unitary limit have been determined by solving exact bound-state and continuum equations in the momentum space. Static magnetic moments and decay rates of magnetic dipole transitions have been calculated for all ground state heavy hadrons using the framework of the quark bag model. The explicit expressions for hyperons electric form factors in SU(3) soliton model were derived. Geometric algebra package was implemented in Mathematica language https://github.com/ArturasAcus/GeometricAlgebra , and was used to check formulas of the first part of "Multivector handbook" (about 90 pages, in preparation together with prof. A. Dargys).

Main publications:

A. Deltuva, A. C. Fonseca, Three-cluster breakup in deuteron-deuteron collisions: Single-scattering approximation, Phys. Rev. C 93, 044001 (2016).

R. Alvarez-Rodrıguez, A. Deltuva, M. Gattobigio, and A. Kievsky, Matching universal behavior with potential models, Phys. Rev. A 93, 062701 (2016).

V. Šimonis, "Magnetic properties of ground-state mesons", Eur. Phys. J. A 52, 90 (2016).

National Research Projects

Research Council of Lithuania. **Theoretical study of three-particle nuclear reactions** (No. MIP-094/2015). Dr. A. Deltuva. 2015–2017.
Nuclear reactions in systems consisting of proton, neutron and nuclear core were described using exact three-body Faddeev theory in the form of AGS integral equations for transition operators. They were solved in the momentum-space partial-wave representation. Angular-momentum or parity-dependent nonlocal optical potentials for nucleon-^{16}O scattering able to fit differential cross section data over the whole angular regime were developed and applied to the description of deuteron-^{16}O for elastic scattering and ^{16}O(d,p)^{17}O transfer reactions; an important nonlocality effect was found for the differential cross sections and deuteron analyzing powers, especially in transfer reactions. Implementing the AGS theory in an extended Hilbert space allowing the excitation of the nuclear core, elastic and inelastic scattering and (d,p) transfer reactions of deuterons on ^{10}Be and ^{24}Mg were studied using rotational model for the excitation potential.

Main publications:

A. Deltuva, T*hree-body calculation of elastic and inelastic scattering of deuterons on ^{24}Mg,* Nucl. Phys. A 947, 173 (2016).

A. Deltuva, A. Ross, E. Norvaišas, and F. M. Nunes, *Role of core excitation in (d,p) transfer reactions,* Phys. Rev. C 94, 044613 (2016).

A. Deltuva and D. Jurčiukonis, *Calculation of three-body nuclear reactions with angular-momentum and parity-dependent optical potentials,* Phys. Rev. C 94, 054619 (2016).

International Research Projects

Lithuanian Academy of Sciences. **Lithuanian cooperation with CERN.** Dr. A. Juodagalvis, since 2008.

Activities at the Compact Muon Solenoid (CMS) experiment at CERN focused on the Drell-Yan process measurement in proton collisions at the center-of-mass energy of 13 TeV (data from 2015). The preliminary result was described in physics analysis summary (PAS SMP-16-009). Contribution to the development of the muon system upgrade (the project GEM) has started. Theoretical developments of several theoretical models were done: (1) the Standard model extended with an additional Higgs doublet and 1 or 2 heavy neutrinos, (2) a

renormalizable supersymmetric SO(10) Grand Unified Theory, and (3) a scotogenic model with a dark sector.

Main publications:

ATLAS and CMS Collaborations, Measurements of the Higgs boson production and decay rates and constraints on its couplings from a combined ATLAS and CMS analysis of the LHC pp collision data at sqrt(s)=7 and 8 TeV, JHEP 08 (2016) 045.

CMS Collaboration, Measurement of long-range near-side two-particle angular correlations in pp collisions at sqrt(s)=13 TeV, Phys. Rev. Lett. 116 (2016) 172302.

P. M. Ferreira, W. Grimus, D. Jurčiukonis and L. Lavoura, *Flavour symmetries in a renormalizable SO(10) model*, Nuclear Phys. B 906, 289 (2016).

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INOVATION) PARTNERS

Nuclear Physics Center at Lisbon University (Portugal)

Istituto Nazionale Fisica Nuclear, Pisa (Italy)

Institute for Theoretical Physics II, Ruhr University Bochum (Germany)

University of Seville, Seville (Spain)

Ohio University, Athens, Ohio (USA)

National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing (USA)

Triangle Universities Nuclear Laboratory, Durham, North Carolina (USA)

Jagiellonian University, Cracow (Poland)

University of Nebraska-Lincoln, Lincoln, Nebraska (USA)

Seoul National University, Seoul (Korea)

European Organization for Nuclear Research CERN (Switzerland)

Joint Institute for Nuclear Research (Dubna, Russia)

Centre for Theoretical Particle Physics, University of Lisbon, CFTP (Portugal)

OTHER SCIENTIFIC ACTIVITIES

Dr. A. Juodagalvis –

- Contact person for the CMS outreach and communication in Lithuania, representing the Lithuanian Team at CERN CMS experiment (since 2015);
- Chairman of the Committee to Coordinate Vilnius University Collaboration with CERN (since 2016).

DEPARTMENT OF THE THEORY OF PROCESSES AND STRUCTURES

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STAFF

Chief research fellows: Prof. Dr. Habil. B. Kaulakys, Dr. Habil. G. Juzeliūnas, Dr. (HP) V. Gontis, Prof. Dr. E. Anisimovas (part-time), Dr. J. Ruseckas.
Senior research fellows: Dr. Habil. V. Gineitytė (affiliated), Doc. Dr. D. Šatkovskienė (affiliated), Dr. A. Vektarienė, Dr. G. Vektaris.
Research fellows: Dr. A. Mekys (part-time), Dr. V. Kudriašov (part-time), Dr. V. Novičenko, Dr. J Armaitis (also Marie Currie Fellow), Dr. A. Kononovičius.
Junior research fellows: H.R. Hamedi, T. Andrijauskas (part-time), R. Kazakevičius (part-time), V. Juknevičius.
Doctoral students: T. Andrijauskas, H. R. Hamedi, R. Kazakevičius.
Technicians: M. Račiūnas (part-time), G. Žlabys (part-time).

RESEARCH INTERESTS

Quantum optics and ultra-cold atoms

Bose-Einstein condensates

Condensed matter systems

Quantum chemistry

Spectroscopy, phase transitions

Condensed molecular structures

Synchronization phenomena in complex networks

Econophysics and physics of finance

Fluctuations and noise, theory of 1/f noise

RESEARCH PROJECTS CARRIED OUT IN 2016

Projects Supported by University Budget

Optical and Kinetic Properties of Cold Atoms and Condensed Molecular Structures.
Habil. Dr. G. Juzeliūnas, 2011–2016.

A superfluid transition has been analyzed in a bilayer system of ultra-cold Fermi gases. It was demonstrated that a critical value of the magnetic field can be significantly increased by including a spin-flip tunneling between the layers. This opens a gap in the spin-triplet channel near the Fermi surface and hence reduces the influence of the effective magnetic field on the superfluidity. A scheme of a high-precision two- and three-dimensional (3D) atom localization has been proposed and analyzed by using a density matrix method for a five-level atom-light coupling scheme. It was found that by properly selecting the control parameters of the system, almost a nearly perfect two-dimensional atom localization can be obtained. Limit cycle oscillators have been studied under a high frequency perturbation with slowly modulated amplitude. A theory has been developed for obtaining an optimal envelope waveform that achieves the maximal frequency interval of entrained oscillators. The evolution of interactions between filled and empty localized orbitals along intrinsic reaction coordinate has been investigated for aromatic heterocycles.

Main publications:

J-H. Zheng, D.-W. Wang and G, Juzeliūnas, Superfluidity enhanced by spin-flip tunnelling in the presence of a magnetic field, Scientific Reports 6, 33320 (2016).

H. R. Hamedi and G. Juzeliūnas, Phase-sensitive atom localization for closed-loop quantum systems, Phys. Rev. A 94, 013842 (2016).

M. Fleishhauer and G. Juzeliūnas, Slow, Stored and Stationary Light, In: Optics in Our Time, eds. M.D. Al-Amri et al. (Springer, 2016), pp. 359-383.

Theory and Applications of Processes in Complex Systems. Prof. B. Kaulakys. 2011–2016.

Nonlinear stochastic differential equations as source of 1/f noise have been generalized by proposing a system of two coupled nonlinear stochastic differential equations, yielding the almost arbitrary steady-state density of the signal. A distinction between the internal time of the system and the physical time has been suggested as a source of 1/f noise. A nonlinear stochastic differential equation giving both the power-law behavior of the power spectral density and the long-range dependent inverse cubic law of the cumulative distribution have been proposed. This is achieved using a suggestion that evolution from calm to violent behavior leads to a decrease of the delay time of multiplicative feedback of the system in comparison to the driving noise correlation time. We show that the power-law properties and the scaling of return intervals and other financial variables have a similar origin and could be a result of a general class of non-linear stochastic differential equations derived from a master equation of an agent system that is coupled by herding interactions.

Main publications:

J. Ruseckas, R. Kazakevičius and B. Kaulakys, Coupled nonlinear stochastic differential equations generating arbitrary distributed observable with 1/f noise, J. Stat. Mech. **2016**, P043209 (2016).

B. Kaulakys, M. Alaburda and J. Ruseckas, Modeling of long-range memory processes with inverse cubic distributions by the nonlinear stochastic differential equations, J. Stat. Mech. 2016, P054035 (2016).

V. Gontis, S. Havlin, A. Kononovicius, B. Podobnik, H.E. Stanley, Stochastic model of financial markets reproducing scaling and memory in volatility return intervals, Physica A 462, 1091 (2016).

National Research Projects

Research Council of Lithuania. **Novel Optical Lattices** (No. MIP-86/2015). Dr. Habil. G. Juzeliūnas. 2015–2018.

A cold-atom realization of a semi-synthetic zigzag ladder affected by a magnetic flux has been proposed and analyzed. It was found that interplay between the frustration induced by the magnetic field and the interactions gives rise to a non-trivial gapped phase at fractional filling factors corresponding to one particle per magnetic unit cell. The ground-state behavior has been investigated for a Bose-Einstein Condensate in a Raman-laser-assisted one-dimensional optical lattice potential forming a bilayer and multilayer structures. A method has been proposed and analyzed for creating far-field optical barrier potentials for ultracold atoms with widths that are narrower than the diffraction limit and can approach tens of nanometers. It was found that the spin dynamics affects the orbital motion of solitons leading to spin-orbit effects in the dynamics of macroscopic quantum objects (mean-field solitons).

Main publications:

E. Anisimovas, M. Račiūnas, C. Strater, A. Eckardt, I. B. Spielman, and G. Juzeliūnas, Semisynthetic zigzag optical lattice for ultracold bosons, Phys. Rev. A 94, 063632 (2016).

S.-W. Su, S.-C. Gou, Q. Sun, L. Wen, W.-M. Liu, A.-C. Ji, J. Ruseckas, and G. Juzeliūnas, Rashba-type spin-orbit coupling in bilayer Bose-Einstein condensates, Phys. Rev. A 93, 053630 (2016).

M. Račiūnas, G. Žlabys, A. Eckardt, and E. Anisimovas, Modified interactions in a Floquet topological system on a square lattice and their impact on a bosonis fractional Chern insulator state, Phys. Rev. A 93, 043618 (2016).

Research Council of Lithuania. **Quantum phases and phase transitions in restricted-geometry condensates** (No. APP-4/2016). Prof. dr. E. Anisimovas. 2016–2019.

Project started in April of 2016. During the first year the research focused on the possibilities to stabilize fractional quantum Hall-like phases in small samples, as well as on the motion of a wave packet in the presence of spin-orbit coupling. One publication was submitted to Physical Review A.

International Research Projects

Taiwan-Latvia-Lithuania joint research project **Quantum and Nonlinear Optics with Rydberg-State Atoms** (TAP LLT-2/2016) Dr. J. Ruseckas. 2016 – 2018.

During the first year a new method to create two-photon states in a controllable way using interaction between the Rydberg atoms during the storage and retrieval of slow light has been proposed. Interaction between the atoms during the storage period creates entangled pairs of atoms in a superposition state that is orthogonal to the initially stored state. Restoring the slow light from this new atomic state one can produce a two photon state with a second-order correlation function determined by the atom-atom interaction and the storage time. Measurement of the restored light allows one to probe the atom-atom coupling by optical means with a sensitivity that can be increased by extending the storage time. A publication on this topic was submitted to Phys. Rev. A.

EU Horizon 2020 Marie Skłodowska-Curie Fellowship **Spin Transport in Interacting Spin-Orbit Coupled Systems.** Dr. J. Armaitis. 2016–2018.

The physics of charge and spin transport is the basis of current consumer devices. Recent discoveries in solid-state physics have highlighted the importance of the coupling of the electron's motion to its spin for transport phenomena. However, our understanding of transport with this so-called spin-orbit coupling has been largely limited to non-interacting systems, even though the first experimental systems with well-controlled spin-orbit coupling and interactions are already available. Here, we aim to provide a theoretical description of these novel interacting spin-orbit coupled systems. More concretely, we will derive equations describing the motion of spin and mass and solve these equations. We will investigate spin transport in the uncharted regime where the inter-particle interactions compete with spin-orbit coupling. In particular, we will quantify the robustness of the familiar transport phenomena (e.g., the spin Hall effect) in the presence of interactions.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INNOVATION) PARTNERS

National Institute of Standards and Technology (USA)

National Tsing Hua University (Taiwan)

Heriot-Watt University (UK)

ICREA and ICFO (Spain)

Leibniz Universität, Hannover (Germany)

University of Latvia, Riga (Latvia)

Boston University (USA)

OTHER SCIENTIFIC ACTIVITIES

Prof. B. Kaulakys –

- member of the Institute of Physics (UK);
- member of the European Physical Society;
- editorial board member of the Lithuanian Journal of Physics;
- editorial board member of the journal Nonlinear Analysis. Modeling and Control;
- vice-president of the Lithuanian Association of Nonlinear Analysts;
- council member of the Lithuanian Scientific Society;
- member of the Senate of Vilnius University.

Dr. Habil. G. Juzeliūnas –

- associated member of the National Center for Theoretical Sciences at the National Tsing Hua University, Taiwan;
- member of the Institute of Physics (UK).

Dr. V. Gontis –

- member of the association of *Euroscience*, http://www.euroscience.org/
- president of the Lithuanian Scientific Society till May 2016.

PLANETARIUM

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Director – *Danutė Sperauskienė*

STAFF

Lecturers: R. Paškevičiūtė, A. Sadauskas, D. Sperauskienė

Engineer: D. Mešalkin

Booking-clerk: A. Kvaraciejienė

Photographer: G. Janavičius (part-time).

International and National Projects

Researchers' Night 2016: Researchers on and off work (Night2015). D. Sperauskienė.

This project was carried out in Lithuania together with seven other universities and three scientific institutions. The main action took place on the 30 th of September and attracted to Planetarium about 300 visitors for about 4 hours. Another big cycle of lectures "Earth and the Universe" comprised 26 meetings with the public. Five events of science festival "Spaceship – Earth" took place at the Planetarium, which attracted 450 visitors. More than 2000 listeners visited a cycle of science and art concerts "Bards in between the Stars" comprised of 12 educational concerts. Altogether about 565 lectures were offered and more than 27 000 people attended Planetarium during 2016.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INOVATION) PARTNERS

International Planetarium Society (Greenville, USA)

The Planetary Society (Pasadena, USA)

Carl Zeiss (Oberkochen, Germany)

Lithuanian Centre of Non-formal Youth Education (Lithuania)