

## Faculty of Physics

### OF THEORETICAL PHYSICS AND ASTRONOMY

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Director – Dr. Habil. *Gražina Tautvaišienė*

#### STAFF

**Distinguished professor:** Habil. Dr. G. Juzeliūnas

**Professors:** Dr. E. Anisimovas, Habil. Dr. A. Bartkevičius (affiliated), Habil. Dr. R. Karazija (affiliated), Prof. Dr. A. Kučinskas (part-time), Habil. Dr. G. Tautvaišienė (part-time), Prof. Dr. (HP) V. Vansevicius (part-time).

**Research professors:** Dr. K. Černis, Dr. A. Deltuva, Prof. Habil. Dr. G. Gaigalas, Dr. (HP) V. Gontis, Doc. Dr. V. Jonauskas, Dr. H. Kjeldsen, Prof. Dr. A. Kučinskas (part-time), Habil. dr. L. Piliugin, Habil. Dr. G. Tautvaišienė (part-time).

**Associate professors:** Dr. A. Drazdauskas (part-time), Doc. Dr. T. Gajdosik, Dr. Š. Mikolaitis (part-time), Dr. D. Narbutis (part-time), Dr. R. Stonkutė (part-time), Dr. K. Zubovas (part-time), Doc. Dr. D. Šatkovskienė (affiliated).

**Senior researchers:** Doc. Dr. A. Acus, Dr. A. Drazdauskas (part-time), Dr. C. von Essen, Dr. R. Janulis, Dr. A. Juodagalvis, Habil. Dr. V. Gineitytė (affiliated), Dr. D. Jurčiukonis, Dr. R. Juršėnas, Dr. R. Karpuškienė, Habil. Dr. B. Kaulakys (part-time), Dr. A. Kazlauskas (affiliated), Dr. R. Kisielius, Doc. Dr. A. Kynienė, Dr. A. Kononovičius, Dr. S. Kučas, Dr. Š. Masys, Dr. Š. Mikolaitis (part-time), Dr. R. Minkevičiūtė, Prof. Dr. (HP) E. Norvaišas (affiliated), Dr. V. Novičenko, Dr. E. Pakštienė, Dr. L. Radžiūtė, Dr. V. Regelskis, Dr. P. Rynkun, Dr. J. Sperauskas (affiliated), Dr. E. Stonkutė, Dr. J. Tamulienė, Dr. A. Vektarienė, Dr. G. Vektaris (affiliated), Dr. C. von Essen, Dr. J. Zdanavičius.

**Researchers:** Dr. Y. Chorniy, Dr. V. Čepas (part-time), Dr. V. Dobrovolskas, Dr. V. Dūdėnas, Dr. H. R. Hamedi, Dr. R. Kazakevičius, Dr. J. Klevas, Dr. V. Kudriašov (part-time), Dr. M. Maskoliūnas, Dr. A. Mekys (part-time), Dr. A. Momkauskaitė, Dr. M. Mackoīt-Sinkevičienė, Dr. C. Viscasillas Vazquez, Dr. Vincentas Mulevičius (from 2022-12-01)

**Research assistants:** E. Kolomiecenas, M. Račiūnas, S. Raudeliūnas (part-time), G. Žlabys.

**Project-specialists:** M. Ambrozas (part-time), V. Bagdonas (part-time), D. Burba (part-time), S. Draukšas (part-time), E. Gvozdiovas (part-time), M. Račiūnas (part-time), G. Žlabys (part-time).

**Doctoral students:** M. Ambrosch, M. Ambrozias, B. Bale, Y. Braver, S. Draukšas, E. Gvozdiovas, E. Kolomiecias, J. Koncevičiūtė, E. Lediniauskas, A. Sharma, R. Skorulskienė, R. Urbonavičiūtė, A. Vitkus.

**Non-academic staff:** V. Bagdonas (part-time), V. Kakarienė (part-time), B. Kavaliauskienė, S. Leišis (part-time), S. Lovčikas, R. Mikutavičienė, Ž. Naimovičienė, R. Urbonavičiūtė (part-time).

## **RESEARCH AREAS**

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

## **RESEARCH INTERESTS**

Galactic structure and chemodynamical evolution of stellar populations

Chemical composition and mixing phenomena in stellar atmospheres

Convection and non-equilibrium radiative transfer in stellar atmospheres

Stellar asteroseismology

Planet hosting stars and exoplanet transits

Structure and evolution of galaxies

Search and positional observations of comets and asteroids

Theoretical atomic spectroscopy

Algorithms and computer programs for plasma physics, astrophysics and other fields

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

Interactions of atoms and molecules with electrons and radiation

Theoretical investigation of crystalline and electronic structure of perovskite crystals

Algebraic techniques for nuclear and particle physics

Analysis of pp collision data recorded at CERN CMS experiment

Neutrinos in the extended Standard model

Scattering processes in few-body nuclear systems

Quantum optics and ultra-cold atoms

Bose-Einstein condensates

Condensed matter systems

Quantum chemistry

Complexity and statistical physics applications in economics, finance, and other social sciences

Fluctuations and noise, theory of 1/f noise

## ***DOCTORAL DISSERTATIONS MAINTAINED IN 2022***

Carlos Viscasillas Vazquez “Chemical abundances of neutron capture elements in the Milky Way”, 2022/09/14.

Giedrius Žlabys “Ultracold atom dynamics in quasi-one-dimensional optical lattices”, 2022/06/21.

## ***MAIN CONFERENCES ORGANIZED IN 2022***

14th European Conference on Atoms Molecules and Photons, June 27 - July 1, 2022, Vilnius.

International conference “Europlanet Telescope Science Workshop”, February 9 - 11, 2022, Vilnius (virtual).

## ***MAIN SCIENTIFIC ACHIEVEMENTS IN 2022***

NGC1851 is one of several stellar globular clusters for which multiple stellar populations of the subgiant branch have been identified with different metallicity. A crucial piece of information on the formation history of this cluster was provided by determining the sum of (C+N+O) abundances in the two populations and the evidence given that NGC1851 is composed of two clusters, the metal-rich cluster being by about 0.6 Gyr older than the metal-poor one. A global overview of NGC1851 properties and the detailed abundances of chemical elements favour its formation in a dwarf spheroidal galaxy that was accreted by the Milky Way. The work was performed by G. Tautvaišienė in collaboration with the coworkers of the Gaia-ESO Survey.

The teams lead by professors Gediminas Juzeliūnas (Vilnius University) and Emilia Witkowska (Institute of Physics, PAS, Warsaw) analysed a novel way of creating spin squeezing for ultracold atoms in optical lattices by illuminating atoms with a properly chosen external laser light. This idea can increase the accuracy of measuring the frequency of atomic transitions in extremely stable and super-accurate clocks based on fermionic atoms in optical lattices. The results were published in the prestigious journal “Physical Review Letters”.

## ***RESEARCH PROJECTS CARRIED OUT IN 2022***

### **Projects Supported by University Budget**

**Chemical composition of stars and exoplanets, and chemical evolution of the Galaxy.** Dr. Habil. G. Tautvaišienė. 2021–2025.

We reviewed some observational results obtained during the last decade that contributed to a better understanding of the stellar asymptotic giant branch phase: the growth of s-process abundances at recent epochs, i.e., in the youngest stellar populations; the different relations between age and [s/Fe] in distinct regions of the disc; and finally the use of s-process abundances combined with those of  $\alpha$ -elements, [s/ $\alpha$ ], to estimate stellar ages. We revised some implications

that these observations had both on stellar and Galactic evolution, and on our ability to infer stellar ages. Also we studied the stellar mass–metallicity relation of an extended sample of star-forming galaxies in the local Universe and its possible dependence on the star formation rate.

### **Main publications:**

Magrini, Laura, Viscasillas Vázquez, Carlos, Casali, Giada, Baratella, Martina, D'Orazi, Valentina, Spina, Lorenzo, Randich, Sofia, Cristallo, Sergio, and Vescovi, Diego, The Abundance of S-Process Elements: Temporal and Spatial Trends from Open Cluster Observations, 2022, *Universe*, 8, 64.

Duarte Puertas, S., Vilchez, J. M., Iglesias-Páramo, J., Mollá, M., Pérez-Montero, E., Kehrig, C., Pilyugin, L. S., and Zinchenko, I. A., Mass-metallicity and star formation rate in galaxies: A complex relation tuned to stellar age, 2022, *Astronomy and Astrophysics*, 666, A186.

Pilyugin, L. S., Lara-Lopez, M. A., Vilchez, J. M., Duarte Puertas, S., Zinchenko, I. A., Dors Jr., O. L., Calibration-based abundances in the interstellar gas of galaxies from slit and IFU spectra, *Astronomy and Astrophysics*, 668, A5

### **Star formation and dust clouds in the Orion and Perseus arms of the Galaxy.** Prof. V. Straizys. 2021–2022.

Two open star clusters Berkeley 86 and Berkeley 87 were investigated using photometry of stars in the Vilnius seven-color photometric system and the astrometric data from Gaia space observatory of ESA. Photometric spectral classes, luminosities and interstellar extinctions are determined for stars down to  $V = 19.0$  mag. Members of the clusters are identified applying their proper motions, parallaxes and distances taken from the Gaia DR3 catalog. In the area of Berkeley 86 we have observed 1085 stars. Among them about 740 have the classification quality  $\sigma_Q$  better than 0.05. The region of Berkeley 87 contains roughly two times fewer stars in the same sized  $13 \times 13$  arc min field. There we have observed 502 stars. It is evident that in the direction of both clusters the steep rise of the extinction up to 2 mag happens at 600–800 pc. The character of extinction at greater distances is different: while in the direction of Berkeley 86 the following rise is quite moderate up to 3–3.5 mag at 3 kpc, but in the direction of Berkeley 87 the steep rise continues up to  $\sim 4.5$ –5 mag. New parameters of the clusters were obtained. Both clusters are almost equidistant - about 1.7 kpc and are of similar ages of 5–10 Myr. The analysis shows a steep increase of the extinction at 500–600 pc which is related to the dust clouds in the Great Cygnus Rift.

### **Main publications:**

Boyle, R. P., Janusz, R., Straizys, V., Černis, K., Zdanavičius, J., Raudeliūnas, S., Kazlauskas, A. Two young clusters in Cygnus. *BAAS*, 54, No. 6., 3 (2022).

### **Magnetohydrodynamical phenomena and radiative transfer in stellar atmospheres.** Prof. Dr. A. Kučinskas. 2020–2024.

We studied abundances of s-process element Zr in the atmospheres of red giant branch stars of the Galactic globular cluster (GGC) 47 Tuc. We find that Zr abundance is weakly correlated with that of Na. The obtained results suggest that possibly the s-process elements have been synthesized by the same polluters that enriched the second population stars with light elements. Potential candidate polluters were proposed. Also we studied a photospheric solar silicon abundance derived using CO5BOLD model atmospheres and the LINFOR3D spectral synthesis

code. We additionally showed the effects of the chosen line sample, broadening due to velocity fields, collisional broadening, model spatial resolution, and magnetic fields. The synthetic spectra were fit to observations in the Hamburg solar atlas. We derived a photospheric solar silicon abundance taking into account a correction from Non-Local Thermodynamic Equilibrium (NLTE) effects.

**Main publications:**

Kolomicas, E., Dobrovolskas, V., Kučinskas, A., Bonifacio, P., Korotin, S. Abundance of zirconium in the globular cluster 47 Tuc: a possible Zr-Na correlation? 2022, *Astronomy and Astrophysics*, 660, A46.

Deshmukh, S. A., Ludwig, H. -G., Kučinskas, A., Steffen, M., Barklem, P. S., Caffau, E., Dobrovolskas, V., Bonifacio, P. The solar photospheric silicon abundance according to CO5BOLD. Investigating line broadening, magnetic fields, and model effects. 2022, *Astronomy & Astrophysics*, 668, A48.

**Stochastic Effects in Stellar Systems.** Prof. Dr. (HP) V. Vansevičius. 2019–2023.

Research activities were carried out in three main directions: i) studies of stochastic star formation history in the dwarf irregular galaxy Leo A; ii) studies of star clusters in the Andromeda galaxy (a new method stochastic cluster classification was developed); iii) studies of active galactic nucleus luminosity histories (a neural network-based approach was proposed).

**Main publications:**

A. Leščinskaitė, R. Stonkutė, V. Vansevičius. Recent star formation history of the dwarf irregular galaxy Leo A. *Astronomy & Astrophysics*, Vol. 660, id.A79, 10 pp. (2022).

R. Stonkutė, V. Vansevičius. Dwarf Irregular Galaxy Leo A. II. Suprime-Cam R and H $\alpha$  Stellar Photometry. *The Astrophysical Journal Supplement Series*, Vol. 259, id.6, 5 pp. (2022).

K. Zubovas, J. Bialopetravičius, M. Kazlauskaitė. Determining active galactic nucleus luminosity histories using present-day outflow properties: a neural network-based approach. *Monthly Notices of the Royal Astronomical Society*, Vol. 515, pp. 1705-1722 (2022).

**Astrometry and photometry of hazard asteroids.** Dr. K. Černis. 2021–2025.

Twenty two new asteroids have been discovered. New large TNO object 2021 XD7 has been discovered, confirmed and was observed doing it's astrometry and photometry in 2022. New precise orbits of two NEO objects were determined. We published about 11000 astrometric positions of 1700 asteroids. Kuiper Belt, Near Earth Objects, Main Belt asteroids and comets were observed with the 0.35/0.51 m Maksutov telescope (Molėtai Observatory), with the 0.80/1.20 m Schmidt telescope (Baldone Observatory, Latvia) and with the 1.83 m Vatican telescope (Mt. Graham, Arizona, U.S.A.). A new precise orbits of 26 comets discovered at the Vilnius observatory and 30 asteroids discovered in the Vatican observatory were determined. We studied the orbital evolution of comet periodic 322P/SOHO discovered in Vilnius with and without non-gravitational effects. It turned out that many of the comet's orbital clones go into

and out of retrograde orbits, sometimes repeatedly. The reason for such dramatic changes in the inclination of the orbit is the origin of comet 322P close to mean motion resonance 3:1 with Jupiter. Noctilucent clouds were observed in summer time from the Vilnius ITPA station. Four asteroids were named by Mažvydas (309206), Daukantas (592249), Karazija (363706) and Rietavas (604827).

### **Main publications:**

K. Černis, R. P. Boyle. The discovery of new TNO object 2021 XD7 in Mt. Graham Observatory (Code 290). M.P.E.C. 2022-T132 (Oct. 12).

I. Włodarczyk, K. Černis, R. P. Boyle. Observational data and orbits of the asteroids discovered at the VATT Observatory in 2010-2012. *Bulg. A. J.*, 37 (2022).

I. Włodarczyk, K. Černis. Observational data and orbits of the comets discovered at the Vilnius Observatory in 1980-2006 and the case of comet P/322. *Open Astron.*, 31, 244 (2022).

### **Multielectron processes in complex atomic systems. Dr. V. Jonauskas. 2019–2023.**

Emission produced by radiative and Auger cascade following a creation of the K-shell vacancy in the iodine atom is investigated by considering transitions among subconfigurations. Multiple photoionization is analysed as a result of radiative and Auger cascade following ionization by photon from the 2s and 2p subshells. Transformed radial orbitals with the quasirelativistic approach were applied to investigate spectral properties of the W<sup>30+</sup> ion. The structures of 30 paramagnetic defects were modeled by introducing them into hydrogenated nanodiamond of C<sub>84</sub> size and performing geometry optimization.

### **Main publications:**

R. Karpuškienė, R. Kisielius. Theoretical level energies and transition data for 4p<sup>6</sup> 4d<sup>8</sup>, 4p<sup>5</sup> 4d<sup>9</sup> and 4p<sup>6</sup> 4d<sup>7</sup>4f configurations of W<sup>30+</sup> ion. *Atomic Data and Nuclear Data Tables* 143, 101478 (2022). DOI: 10.1016/j.adt.2021.101478

S. Kučas, A. Kynienė, Š. Masys, V. Jonauskas, Multiple photoionization for the 2s subshell in the iron atom, *Mon. Not. R. Astron. Soc.* 516, 3113–3119 (2022). DOI: 10.1093/mnras/stac2461

S. Kučas, A. Momkauskaitė, A. Kynienė, Š. Masys, V. Jonauskas, Evaluation of radiative and Auger electron emission following K-shell vacancy creation in iodine, *J. Quantitative Spectroscopy and Radiative Transfer* 288, 108249 (2022). DOI: 10.1016/j.jqsrt.2022.108249

### **Correlation and relativistic effects in complex atoms and ions. Prof. G. Gaigalas. 2020–2024.**

Energy spectra calculations were done for 225 levels for the Ce<sup>3+</sup> ion. The root-mean-square deviations obtained for the GRASP2018 energy levels of the 5p<sup>6</sup>nl configurations from the NIST data are 1270 cm<sup>-1</sup>. Furthermore, E1 transition data, line strengths, weighted oscillator strengths, and transition rates were computed between the above levels. Also, the accuracy of the transition parameters was evaluated by analyzing the dependencies of the line strength *S* on

the gauge parameter  $G$ . Using this data, the opacities in the neutron star merger ejecta were also calculated.

### **Main publications:**

**P. Rynkun**, S. Banerjee, **G. Gaigalas**, M. Tanaka, **L. Radžiūtė**, and D. Kato. Theoretical Investigation of Energy Levels and Transition for Ce IV, *Astronomy & Astrophysics* **658**, A82 (2022). (<https://doi.org/10.1051/0004-6361/202141513>)

**G. Gaigalas**, **P. Rynkun**, S. Banerjee, M. Tanaka, D. Kato, and **L. Radžiūtė**, Theoretical investigation of energy levels and transitions for Pr IV, *Monthly Notices of the Royal Astronomical Society*, **517**, 281-293 (2022). (<https://doi.org/10.1093/mnras/stac2401>)

J. Q. Li, C. Y. Zhang, G. Del Zanna, P. Jönsson, M. Godefroid, **G. Gaigalas**, **P. Rynkun**, **L. Radžiūtė**, K. Wang, R. Si, and C. Y. Chen, Large-scale Multiconfiguration Dirac–Hartree–Fock Calculations for Astrophysics: C-like Ions from O III to Mg VII, *The Astrophysical Journal Supplement Series*, **260**, 50 (2022). (<https://doi.org/10.3847/1538-4365/ac63ae>)

### **Theoretical Study of Light Nuclei and Elementary Particles.** Dr. A. Deltuva. 2021–2025.

Dimer-dimer scattering in the system of four He-4 atoms was described using a newly proposed “softening and extrapolation” method to include realistic potentials. Delta-isobar effects in the electrodisintegration of He-3 were shown to be sizable for inclusive asymmetries in special kinematic regimes.

Explicit formulas for exponents and logarithms were obtained for diagonalizable multivectors of arbitrary  $Cl(p,q)$  Clifford algebras.

Bethe vectors for twisted Yangian based models were studied, recurrential relations were obtained.

### **Main publications:**

A. Deltuva. Signatures of the Delta isobar in spin observables of He-3 electrodisintegration. *Physics Letters B* 835 (2022) 137552

V. Regelskis. Algebraic Bethe Ansatz for spinor R-matrices, *SciPost Phys.* 12, 067 (2022)

A. Deltuva. Four-body system of 4 He atoms: Dimer-dimer scattering. *PHYSICAL REVIEW A* 105, 043310 (2022)

### **Topological and kinetic properties of cold atoms and condensed molecular systems.** Habil. Dr. G. Juzeliūnas, 2022–2026.

A symmetrical two-dimensional electromagnetically induced grating has been theoretically studied for a four-level N-type atomic system. Interaction of light with a two-level system has been investigated in a hybrid cavity system. 1,3,7-trimethylxanthine vibrational spectrum has been investigated aiming to evaluate activation energies of methyl groups rotation. Influence of acetonitrile and ethyl acetate on fluorescence of tirapazamine has been studied with a different number of oxygen atoms. It is shown that the Weyl family determines a boundary triple.

### **Main publications:**

Seyyed Hossein Asadpour, Hamid R. Hamed, Teodora Kirova, and Emmanuel Paspalakis, Two-dimensional electromagnetically induced phase grating via composite vortex light, *Phys. Rev. A* **105**, 043709 (2022).

Ziauddin, Muqaddar Abbas, Ayesha Basharat, You-Lin Chaung, Zahida Ehsan & Hamid R. Hamed, Two-color transparency in a hybrid photothermal cavity system, *The European Physical Journal Plus* **137**, 909 (2022).

J. Sarlauskas, K. Tulaite and J. Tamuliene, Investigation of oxygen influence to the optical properties of tirapazamine, *J. Mol. Model.* **28(4)**:96 (2022) doi: 10.1007/s00894-022-05085-z.

### **Complex nonlinear phenomena in stochastic physical and social systems**

Habil. dr. V. Gontis. 2022–2025.

The order disbalance time series constructed from the limit order book data of the financial markets investigated from the general fractional Lévy stable motion perspective. Results suggest that previous findings of persistence in order flow could be related to the power-law distribution of order sizes and other deviations from the normal distribution. The statistical properties of a temporal point process driven by a confined fractional Brownian motion analyzed. The event count distribution and power spectral density of this non-Markovian point process exhibit power-law scaling. This result indicates a possible link between nonlinearity and apparent non-Markovian behavior.

### **Main publications:**

V. Gontis. Order flow in the financial markets from the perspective of the Fractional Lévy stable motion. *Communications in Nonlinear Science and Numerical Simulation* **105**, 2022, psl. 106087.

A. Kononovicius, R. Kazakevičius, B. Kaulakys. Resemblance of the power-law scaling behavior of a non-Markovian and nonlinear point processes. *Chaos, Solitons & Fractals* **162**, 112508 (2022).

### **National Research Projects**

Global Grant research project „**Stellar and exoplanet investigations in the context of the TESS and JWST space missions**” (No. 09.3.3-LMT-K-712-01-0103) Dr. habil. G. Tautvaišienė, 2018 – 2022.

In fulfilling the aims of the NASA planetary and asteroseismic research mission “Transiting Exoplanet Survey Satellite” (TESS), we have observed high-resolution spectra for all 848 bright ( $V < 8$  mag) stars that are cooler than F5 spectral class in the area up to 12 deg surrounding the northern TESS continuous viewing zone and uniformly determined the main atmospheric parameters, ages, orbital parameters, velocity components, and precise abundances of up to 24 chemical species. The analysis of 25 planet-hosting stars in our sample drove us to the following conclusions: the dwarf stars hosting high-mass planets are more metal rich than those with low-mass planets. We find slightly negative C/O and Mg/Si slopes toward the stars with high-mass



planets. All the low-mass planet hosts in our sample show positive  $\Delta[\text{El}/\text{Fe}]$  versus condensation temperature slopes, in particular, the star with the largest number of various planets. The high-mass planet hosts have a diversity of slopes, but in more metal-rich, older, and cooler stars, the positive elemental abundance slopes are more common.

**Main publications:**

Tautvaišienė, G., Mikolaitis, Š., Drazdauskas, A., Stonkutė, E., Minkevičiūtė, R., Pakštienė, E., Kjeldsen, H., Brogaard, K., Chorniy, Y., von Essen, C., Grundahl, F., Ambrosch, M., Bagdonas, V., Sharma, A., and Viscasillas Vázquez, C., Chemical Composition of Bright Stars in the Northern Hemisphere: Star-Planet Connection, 2022, The Astrophysical Journal Supplement Series, 259, 45.

Huber, Daniel, ... Kjeldsen, Hans, ... Pakštienė, Erika et al., A 20 Second Cadence View of Solar-type Stars and Their Planets with TESS: Asteroseismology of Solar Analogs and a Recharacterization of  $\pi$  Men c, 2022, The Astronomical Journal, 163, 79.

Global Grant research project “**Quantum engineering in cold atomic gasses**” (No. 09.3.3-LMT-K-712-01-0051) Prof. E. Anisimovas, 2018 – 2022.

The method of flow equations was generalized to describe quantum systems subject to a time-periodic drive with a time-dependent envelope. In this approach, the time evolution of the system is described in terms of the phase-independent effective Hamiltonian and the complementary micromotion operator that are generated by deriving and solving the flow equations. These equations implement the evolution with respect to an auxiliary flow variable and facilitate a gradual transformation of the quasienergy matrix into a block-diagonal form in the extended space.

**Main publications:**

V. Novičenko, G. Žlabys, and E. Anisimovas, Flow-equation approach to quantum systems driven by an amplitude-modulated time-periodic force, Physical Review A 105, 012203 (2022).

Research group project “**Optical Control of Ultracold atoms**” funded by Research Council of Lithuania (S-MIP-20-36). 2020–2023. Prof. dr. G. Juzeliūnas.

Topological charge pumping was studied in subwavelength Raman lattices. By introducing an adiabatically varied phase in the driving protocol, Thouless pumping was demonstrated in a time crystalline structure.

**Main publications:**

Y. Braver, C.-h. Fan, G. Žlabys, E. Anisimovas, and K. Sacha, Two-dimensional Thouless pumping in time-space crystalline structures, Physical Review B 106, 144301 (2022).

D. Burba, M. Račiūnas, I. B. Spielman and G. Juzeliūnas, Topological charge pumping with subwavelength Raman lattices, arXiv:2210.05515 (Submitted to Phys. Rev. A).

Research project “**Spin-orbit coupling for the generation of non-trivial quantum correlations in ultra-cold atomic systems**” funded by the Research Council of Lithuania (S-LL-21-3) for the scientific collaboration between Lithuanian and Polish scientists. Project leader – Gediminas Juzeliūnas.

It was shown that one-axis twisting and two-axis counter-twisting mechanisms of squeezing mechanisms can be generated for ultracold atomic fermions in the Mott insulating phase by a position-dependent laser coupling of atomic internal states.

#### **Main publications:**

T. Hernández Yanes, M. Płodzień, M. Mackoīt Sinkevičienė, G. Žlabys, G. Juzeliūnas, E. Witkowska, Phys. Rev. Lett. 129, 090403 (2022).

Research project “**Coherent Optical Control of Atomic Systems**” funded by Research Council of Lithuania for the scientific collaboration between Lithuanian, Latvian and Taiwanese scientists (2022-2024). Project leader – Gediminas Juzeliūnas.

The project started this year. During the first year of the project the behavior of an Electromagnetically Induced Grating has been investigated in a four-level quantum system located near a plasmonic nanostructure. This study shows a simple scheme for double control over the diffraction efficiency of the two-dimensional grating, by utilizing both the winding number of the vortex field, and the distance between the quantum system and the plasmonic nanostructure as control knobs. A paper on this subject has been submitted for publication.

Research group project “**Few-cluster nuclear reactions: towards many-body problem**” funded by Research Council of Lithuania (S-MIP-22-72). 2022–2025. Dr. A. Deltuva

Proton scattering on He-3 nucleus at intermediate energies was calculated using rigorous momentum-space integral equations for transition operators. Delta-isobar effects on the differential cross section and spin-correlation coefficients were evaluated and compared with the experimental data.

#### **Main publications:**

A. Watanabe, S. Nakai, K. Sekiguchi, A. Deltuva, et al. Spin correlation coefficient for proton-He-3 elastic scattering at 100 MeV. PHYSICAL REVIEW C 106, 054002 (2022)

Research Council of Lithuania. **Polish – Lithuanian Black Hole hunt** (S-LL-19-2). Dr. M. Maskoliūnas. 2019 – 2022.

Within a frame of the project, ground-based photometric follow-up observations “Gaia Alerts” (GA) objects with the telescopes of Molėtai astronomy observatory (MAO) have been carried out. Members of the project arranged the observation program and data analysis of each observation item. The 2022 campaign of MAO observations resulted in more than 350 measurement points, necessary for a drawing of 17 objects light curves. All the observation data are placed in “Cambridge Photometric Calibration Server” (CPCS). It is a system for saving up all GA photometric data from various telescopes.

#### **Main publications:**

Kruszyńska, K.; Wyrzykowski, Ł.; Rybicki, K. A.; Maskoliūnas, M.; ... Stankevičiūtė, A.; Čepas, V.; Pakštienė, E.; Šiškauskaitė, K.; Zdanavičius, J.; et al. Lens parameters for Gaia18cbf

a long gravitational microlensing event in the Galactic plane, 2022, *Astronomy & Astrophysics*, 662, 59

Rybicki, K. A.; ... Maskoliunas, M.; Pakstiene, E.; Ratajczak, M.; Stankeviciute, A.; Zdanavicius, J.; Ziółkowska, O. Single-lens mass measurement in the high-magnification microlensing event Gaia19bld located in the Galactic disc, 2022, *Astronomy & Astrophysics*, 657, 18

Research Council of Lithuania postdoctoral fellowship “**Theoretical multipole interference study for gravitational wave sources**” (Nr. 09.3.3-LMT-K-712-19-0080). Dr. L. Radžiūtė, supervisor Prof. Dr. G. Gaigalas, 2020 – 2022.

Accurate energy levels for Sb-like: Sb I–Cs VI were presented, using MCDHF and RCI methods. Accuracy of E1 and E2-type transition was investigated, using quantitative and qualitative evaluation methodology. Special attention was paid to the Te II, because of its importance to the opacity investigation. Also, the most suitable elements for the multipole interference, according to the admixing coefficient, were found. The accuracy of expected and unexpected transitions was evaluated using new methodology.

#### **Main publications:**

**L. Radžiūtė, G. Gaigalas**, Energy levels and transition properties for As-like ions Se II, Br III, Kr IV, Rb V, and Sr VI, *Atomic Data and Nuclear Data Tables*, **147**, 101515 (2022). (<https://doi.org/10.1016/j.adt.2022.101515>)

Research Council of Lithuania postdoctoral fellowship “**Study of the Grimus-Neufeld model**” (Nr. 09.3.3-LMT-K-712-19-0013). Dr. V. Dūdėnas, supervisor Assoc. Prof. Dr. Thomas Gajdosik, 2020 – 2022

We studied lepton flavor violating processes in the Grimus-Neufeld model in the tiny seesaw scenario. We performed parameter scans using Flexible-SUSY to constrain the scalar sector from 2-body and 3-body charged lepton-flavor-violating decays and the neutrino data. We identify the similarities between the Grimus-Neufeld, scotogenic and the scoto-seesaw models in the limit of the tiny sterile neutrino mass and give the experimental constraints for all these three models in this parameter region. The results of this work have been published in a paper and presented in two conferences.

#### **Main publications:**

V. Dūdėnas, T. Gajdosik, U. Khasianevich, W. Kotlarski and D. Stöckinger, Charged lepton flavor violating processes in the Grimus-Neufeld model, *JHEP* 09 (2022) 174, [2206.00661].

Research Council of Lithuania postdoctoral fellowship “**Spatially inhomogeneous atom-light interaction phenomena**” (Project No. 09.3.3-LMT-K- 712-19-0031) Dr. Hamid R. Hamedi, adviser dr. habil. G. Juzeliūnas, 2020 – 2022.

We considered a method of sub-wavelength superlocalization and patterning of atomic matter waves via a two dimensional stimulated Raman adiabatic passage (2D STIRAP) process. The method allows one to circumvent the restriction set by the diffraction limit inherent to conventional methods for formation of localized solitons, with a full control over the position

and size of nanometer resolution defects. It has been also shown that the noise-induced coherence created via the quantum interference of incoherent radiation in atomic three-level systems of V and  $\Lambda$  types can result in exchange of optical vortices.

#### **Main publications:**

Hamid R. Hamed, Giedrius Žlabys, Verònica Ahufinger, Thomas Halfmann, Jordi Mompart, and Gediminas Juzeliūnas, Spatially strongly confined atomic excitation via a two dimensional stimulated Raman adiabatic passage, *Optics Express* Vol. 30, Issue 9, pp. 13915-13930, (2022).

Seyyed Hossein Asadpour, Ziauddin, Muqaddar Abbas, and Hamid R. Hamed, Exchange of orbital angular momentum of light via noise-induced coherence, *Phys. Rev. A* 105, 033709, (2022).

Research Council of Lithuania postdoctoral fellowship “**Non-classical spin states in ultracold atomic gases**” (Project No. 09.3.3-LMT-K-712-23-0035) Dr. Mažena Mackoit-Sinkevičienė, adviser dr. habil. G. Juzeliūnas, 2021 – 2023.

We presented a systematic analysis of the open boundary conditions and periodic boundary conditions for the squeezing dynamics. We showed that the open boundary conditions weakly influence the level of best squeezing while decreasing the best squeezing time - a key result from an experimental point of view. A paper on this subject is being prepared.

#### **Main publications:**

T. Hernández Yanes, G. Žlabys, M. Mackoit Sinkevičienė, M. Płodzień, E. Witkowska and G. Juzeliūnas, Spin-squeezing in the Heisenberg spin chain with open boundary conditions, 2022-2023, in preparation: *Quantum journal/SciPost Physics*.

Research Council of Lithuania postdoctoral fellowship “**Investigation of long memory in complex multi-state stochastic agent systems**” (Project No. 09.3.3-LMT-K-712-19-0017) Dr. R. Kazakevičius, supervisor dr. V. Gontis, 2020 – 2022. The project completed, awaiting the summary evaluation of the report.

Further exploration of the relationship between multi state agent models and long memory continued. A multivariate agent model that can be interpreted as a voter model with time-varying herd parameter has been investigated. The parameter describing the herding behavior is usually considered to be a random process, but to simplify the problem, the mean estimate of the herding parameter is taken as a stepwise function of time. This simplification made it possible to analytically calculate such indicators of long memory as the first passage times distribution and nonlinear moments growth over time.

#### **Main publications:**

As planned, a scientific article was prepared, which was sent and accepted for review in the periodical scientific publication *Physical Review E*.

Research Council of Lithuania, postdoctoral fellowship “**Barium and strontium abundances in the metal-poor stars as indicators of heavy element nucleosynthesis in the early**

**Universe**” (Nr. 09.3.3-LMT-K-712-19-0172). Dr. J. Klevas, supervisor Prof. Dr. Arūnas Kučinskas, 2020 – 2022.

The strontium abundance was investigated in the red giants of Galactic globular cluster 47 Tuc using the 1D NLTE spectrum synthesis, and 3D LTE-1D LTE abundance corrections. Strontium abundance shows a weak, but statistically significant correlation with sodium abundance, which hints toward high-mass asymptotic giant branch stars as possible polluters in 47 Tuc.

### **Main publications:**

E. Kolomicas, J. Klevas, A. Kučinskas<sup>1</sup>, V. Dobrovolskas, E. Caffau, H.-G. Ludwig, P. Bonifacio, Abundance of strontium in the atmospheres of red giants in Galactic globular cluster 47 Tuc, in preparation: *Astronomy & Astrophysics*

Research Council of Lithuania postdoctoral fellowship “**Lattice systems in topological quantum field theories**” (Nr. S-PD-22-79). Dr. V. Mulevičius, supervisor Dr. Vidas Regelskis, 2022-2024.

Research started aiming to explore physical systems arising from lattices of interacting excitations inside a topological quantum field theory, provide examples of such systems and define the mathematical tools needed to investigate them.

Outsourcing research project “**Integrated science education in Lithuania: achievements and future perspectives**” (No. P-REP-21-8, project funded by LMT) Doc. Dr. A.Kynienė, 2021 – 2022.

After analysing the results of the Lithuanian students' tests and evaluating them, and analysing the questionnaires of teachers, school leaders and students, conclusions and recommendations are presented. These results will be useful for teachers, curriculum innovators, education policy makers and professionals in making decisions to further improve science education. pupil, teacher, classroom, school, municipal and national level.

Students' summer research practice “**Investigation of neutron capture chemical element yttrium abundances in solar neighborhood stars**” funded by Research Council of Lithuania (P-SV-22-108), 2022/07/01 – 2022/08/31. Student – Vilius Bagdonas, project supervisor – Habil. Dr. Gražina Tautvaišienė.

During the summer practice, student Vilius Bagdonas from online astronomical catalogues (2MASS, AllWISE, Gaia EDR3) collected information needed to derive kinematical parameters and ages for 100 stars in the solar neighbourhood. Investigated stars were attributed to the thin and thick Galactic disks from their kinematics and already published abundances of  $\alpha$  chemical elements. Using the spectral synthesis method, out of these 100 stars, for 93 stars yttrium abundances were derived. The results were compared with the theoretical models. The results confirmed that yttrium and magnesium ratio can be used as a chemical clock for the Galactic thin disc stars.

## International Research Projects

EC Horizon2020 project “**EUROPLANET2024 – Research Infrastructure**” (project No. 871149). Dr. Habil. G. Tautvaišienė. 2020 – 2024.

We were working within the work packages dedicated to on-ground observations and early careers training and education. Using observations at the Molėtai Astronomical Observatory, properties of slowly rotating and serendipitous asteroids were investigated as well as transits of exoplanets.

### **Main publications:**

Santos-Sanz P., ... Pakštienė E. et al. Physical properties of the trans-Neptunian object (38628) Huya from a multi-chord stellar occultation, 2022, *Astronomy and Astrophysics*, 664, A130.

EC Horizon 2020 project “**Chemical Elements as Tracers of the Evolution of the Cosmos – Infrastructures for Nuclear Astrophysics (ChETEC-INFRA)**” (grant agreement No. 101008324). Prof. Dr. A. Kučinskas. 2021-2025.

Nuclear astrophysics requires a diverse set of research infrastructures for progress: telescopes for astronomical observations, nuclear laboratories to measure nuclear properties, and supercomputers to compute complex stellar models. ChETEC-INFRA project (<https://www.chetec-infra.eu>) networks 13 infrastructures from a variety of European countries. Under the umbrella of this project, 3 nights have been provided in 2021 at Molėtai astronomical observatory (MAO) for the international project aimed to study the origins of s-process elements using the MAO VUES spectrograph. A. Kučinskas leads a ChETEC-INFRA Work Package 5 (WP5) “Astronuclear Abundances”. A joint ChETEC-INFRA WP5-WP6 workshop has been organized on 2021-07-13 (32 participants from 16 countries).

### **Main publications:**

Korotin, S., Kučinskas, A. Abundance of beryllium in the Sun and stars: the role of non-local thermodynamic equilibrium effects, 2022, *Astronomy and Astrophysics*, 657, L11.

Cescutti, G., Bonifacio, P., Caffau, E., Monaco, L., Franchini, M., Lombardo, L., Matas Pinto, A. M., Lucertini, F., François, P., Spitoni, E., Lallement, R., Sbordone, L., Mucciarelli, A., Spite, M., Hansen, C. J., Di Marcantonio, P., Kučinskas, A., Dobrovolskas, V., Korn, A. J., Valentini, M., Magrini, L., Cristallo, S., Matteucci, F. MINCE I. Presentation of the project and of the first year sample. 2022, *Astronomy & Astrophysics*, in press, DOI: <https://doi.org/10.1051/0004-6361/202244515>.

Lithuanian Academy of Sciences. **Lithuanian cooperation with CERN**. Dr. A. Juodagalvis, since 2008. Project “Physics of subatomic particles in the CERN CMS experiment”.

Activities at the Compact Muon Solenoid (CMS) experiment focused on the analysis of pp collision data recorded with the CMS detector, and the pixel detector prototype testing for the Phase-2 CMS upgrade. The data-driven background estimation procedure for the Drell-Yan

differential cross-section measurement using Run-2 CMS data was implemented in the new analysis framework “Shears” adopted by the CMS group. Various system tests were done to characterize and calibrate the pixel detector prototype chips, several data acquisition software routines were improved. Remote DAQ general shifts on the CMS detector were taken.

The On-Shell renormalization scheme for fermion fields, masses and mixing matrices has been extended to all orders in perturbation theory. A formulation of the On-Shell renormalization for scalars has been defined to all orders in perturbation theory.

Zbb couplings in a left-right model (LRM), two-body lepton-flavour-violating decays in a two-Higgs-doublet model, and the Grimus-Neufeld model were studied.

### **Main publications:**

D. Jurčiukonis and L. Lavoura, Two-body lepton-flavour-violating decays in a 2HDM with soft family-lepton-number breaking, JHEP 03 (2022) 106, [2107.14207].

International programme **Gaia-ESO Spectroscopic Survey** (ESO project 188.B-3002). Dr. Habil. G. Tautvaišienė. 2012 – 2022.

Our main result came from the determination of carbon, nitrogen, and oxygen abundances for evolved giants in the globular cluster NGC1851 which we performed in order to check whether or not the double populations of stars are coeval. We determined that the averaged  $A(C+N+O)$  values between the two populations do not differ, so the additional evidence was given that NGC1851 is composed of two clusters, the metal-rich cluster being by about 0.6 Gyr older than the metal-poor one. A global overview of NGC1851 properties and the detailed abundances of chemical elements favour its formation in a dwarf spheroidal galaxy that was accreted by the Milky Way. Other important results include the age determinations using chemical clocks and the membership determinations for 63 open stellar clusters.

### **Main publications:**

Tautvaišienė, G., Drazdauskas, A., Bragaglia, A., Martell, S. L., Pancino, E., Lardo, C., Mikolaitis, Š., Minkevičiūtė, R., Stonkutė, E., Ambrosch, M., Bagdonas, V., Chorniy, Y., Sanna, N., Franciosini, E., Smiljanic, R., Randich, S., Gilmore, G., Bensby, T., Bergemann, M., Gonneau, A., Guiglion, G., Carraro, G., Heiter, U., Korn, A., Magrini, L., Morbidelli, L., and Zaggia, S., Gaia-ESO Survey: Detailed elemental abundances in red giants of the peculiar globular cluster NGC 1851, 2022, *Astronomy and Astrophysics*, 658, A80.

Viscasillas Vázquez, C., Magrini, L., Casali, G., Tautvaišienė, G., Spina, L., Van der Swaelmen, M., Randich, S., Bensby, T., Bragaglia, A., Friel, E., Feltzing, S., Sacco, G. G., Turchi, A., Jiménez-Esteban, F., D’Orazi, V., Delgado-Mena, E., Mikolaitis, Š., Drazdauskas, A., Minkevičiūtė, R., Stonkutė, E., Bagdonas, V., Montes, D., Guiglion, G., Baratella, M., Tabernero, H. M., Gilmore, G., Alfaro, E., Francois, P., Korn, A., Smiljanic, R., Bergemann, M., Franciosini, E., Gonneau, A., Hourihane, A., Worley, C. C., and Zaggia, S., The Gaia-ESO survey: Age-chemical-clock relations spatially resolved in the Galactic disc, 2022, *Astronomy and Astrophysics*, 660, A135.

Jackson, R. J., Jeffries, R. D., Wright, N. J., Randich, S., Sacco, G., Bragaglia, A., Hourihane, A., Tognelli, E., Degl’Innocenti, S., Prada Moroni, P. G., Gilmore, G., Bensby, T., Pancino, E., Smiljanic, R., Bergemann, M., Carraro, G., Franciosini, E., Gonneau, A., Jofré, P., Lewis, J.,

Magrini, L., Morbidelli, L., Prisinzano, L., Worley, C., Zaggia, S., Tautvaišiene, G., Gutiérrez Albarrán, M. L., Montes, D., and Jiménez-Esteban, F., The Gaia-ESO Survey: Membership probabilities for stars in 63 open and 7 globular clusters from 3D kinematics, 2022, Monthly Notices of the Royal Astronomical Society, 509, 1664.

International programme **PLATO Science Management**. Prof. Dr. A. Kučinskas. 2020 – 2027.

A long-term partnership has been established in late 2020 between the Stellar Atmosphere Physics (SAP) group at ITPA and the European Space Agency's science mission "PLATO" Science Management Work Package 120 "Stellar Science", with prof. dr. A. Kučinskas and dr. J. Klevas becoming the PLATO WP 120 official members. It is foreseen that the SAP group at ITPA will provide the PLATO Science Management consortium with a grid of 3D hydrodynamical model atmospheres of M-type dwarfs which, in cooperation with the PLATO consortium, will be used for the determination of 3D NLTE chemical abundances in the atmospheres of the PLATO target stars. During 2022, computations of the updated version of the M-dwarf grid have been completed at ITPA, and distributed in PLATO consortium, a publication summarizing first scientific results is in preparation, as well as publication by PLATO partners using the M-dwarf grid. The M-dwarf grid was presented in 2 international conferences.

COST Action CA18104 „**Revealing the Milky Way with Gaia**” (ORIGINS) (<https://www.cost.eu/actions/CA18104>). Action Chair: Nicholas Walton) (28 countries). Dr. Š. Mikolaitis, Managing Committee Member, Lead of the Working Group 5. 2019–2023.

The duty of WG5 was to organize the ninth workshop of the MW-Gaia COST Action. It was held in a hybrid form at the Faculty of Optics and Optometry of the University of Santiago de Compostela in Santiago de Compostela, Spain, May 23 - 25, 2022. The event called "Breaking Barriers: Inspiring the Next Generation" aimed to discuss the current state of advances in our understanding of the Milky Way from WG1, WG2, WG3, and WG4 in a context of equal opportunities, education and outreach. Šarūnas Mikolaitis from Vilnius University was a chair of scientific organizing committee and Carlos Viscasillas Vázquez from Vilnius University was a member of the local organizing committee. 11 invited talks, 19 contributed talks and 7 posters were in the programme. 85 participants from 24 countries were registered to attend the workshop.

Carlos Viscasillas Vázquez from Vilnius University acknowledged the support of this cost action (COST Action CA18104) in a paper: Viscasillas Vázquez C., Magrini L. Casali G., "The Gaia-ESO survey: Age-chemical-clock relations spatially resolved in the Galactic disc", 2022, A&A, 660A, 135

Project "**Magnetic properties of nanodiamonds: A large-scale ab initio modeling**" under PRACE DECI-17 Programme within Horizon 2020 Framework. Dr. Š. Masys. 2021 – 2022.

Density functional theory calculations were performed to find out the influence of the size of nanodiamonds (NDs) on the electronic g-tensor values of point defects – nitrogen, silicon, germanium, and nickel complexes exceptionally attractive for bioimaging applications – introduced into the central part of NDs. It was shown that for smaller systems surface effects



play a crucial role, but on the other hand, no saturation of the isotropic g-tensor values occurs even for NDs of much larger size.

NSF Collaborative Project AST/2009811 “**Fulfilling the Atomic Physics Needs for Spectroscopic Diagnostics of Cosmic Chemical Evolution**” PI: Prof. V.P. Kulkarni, Collaborator: R. Kisielius, 2020.09 – 2023.09

The spectral parameters for the low-ionization stage atoms indicative of the cosmic chemical evolution are determined theoretically for use in the absorption spectra modeling and for the deriving of plasma physical parameters. Observation data are utilized in feed-back to determine theoretical data accuracy.

International Atomic Energy Agency, “**Electron-impact ionization for injected impurities into the plasma**” (project No. 26498/SU2213), Dr. V. Jonauskas, 2022-2027

Electron-impact ionization is studied for impurities injected into plasmas of fusion devices. The impurities are used to diminish the heat load on the components of the reactors walls. The ionization cross sections are needed to evaluate charge state distribution in the plasmas. The distorted wave approximation is used to estimate contributions from direct and indirect processes of ionization for the N<sup>+</sup> ion.

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

Aarhus University (Denmark)

European Organization for Nuclear Research CERN (Switzerland)

Astrophysical Institute Potsdam, Potsdam (Germany)

Landessternwarte Heidelberg, University of Heidelberg, Heidelberg (Germany)

Max Planck Institute for Astronomy, Heidelberg (Germany)

Darmstadt University, Darmstadt (Germany)

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

Oslo University, Oslo (Norway)

Osservatorio Astronomico di Trieste, Trieste (Italy)

Uppsala University Observatory, Uppsala (Sweden)

Odessa National University, Odessa (Ukraine)

Center for Physical Sciences and Technology (Lithuania)

National Institute of Standards and Technology (USA)

Capital Normal University, Beijing (China)

University of Patras (Greece)

University of Chicago (USA)

National Institute for Fusion Science (Japan)

National Tsing Hua University, Hsinchu (Taiwan)

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

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

University of Lisbon (Portugal)

University of South Carolina (USA)

Space Telescope Science Institute (USA)

Institute of Electron Physics, Ukrainian National Academy of Sciences (Ukraine)

## **OTHER SCIENTIFIC ACTIVITIES**

### **Prof. Dr. E. Anisimovas**

- chairman of the Council of the Faculty of Physics, Vilnius University;

### **Dr. A. Deltuva**

- member of the international Faddeev medal committee

### **Dr. V. Dobrovolskas –**

- member of the Lithuanian Astronomical Society
- member of the European Astronomical Society

### **Dr. A. Drazdauskas –**

- member of the International Astronomical Union (IAU).

### **Dr. K. Černis –**

- member of the International Astronomical Union (IAU).
- member of the European Astronomical Society.

### **Prof. Habil. Dr. G. Gaigalas –**

- council member of CompAS (The International collaboration on Computational Atomic Structure) group (<https://ddwap.mah.se/tsjoek/compas/index.php> and [CompAS | The international collaboration on Computation Atomic Structure](#))
- editorial board member of the journal Atoms ([Atoms \(mdpi.com\)](#)).
- [Committee member of the 14th European Conference on Atoms Molecules and Photons \(Vilnius, Lithuania, June 27- July 1, 2022\)](#)

**Dr. T. Gajdosik**

- member of the Austrian Physical Society (OePG);
- member of the CERN Baltic Group coordination team “Study group”;
- deputy member of the management committee CA16201 “ParticleFace: Unraveling new physics at the LHC through the precision frontier.”

**Dr. V. Gontis –**

- member of the association of *Euroscience*, <http://www.euroscience.org/>
- council member of the Lithuanian Scientific Society;
- Academic editor of Plos One.

**Dr. V. Jonauskas -**

- Member of International Program Committee, Bari, Italy (ICAMDATA 2022);
- member of the Council of the Faculty of Physics, Vilnius University;
- member of the Lithuanian Physics Society.

**Dr. A. Juodagalvis –**

- Lithuanian representative in CERN Finance Committee (since 2018);
- member of the Council of Experimental nuclear and particle physics center at the Faculty of Physics of Vilnius University (since 2018);
- member of the Board of Lithuanian Physics Society (since 2018), scientific secretary.
- member of the management committee CA16201 “ParticleFace: Unraveling new physics at the LHC through the precision frontier;”
- deputy team leader of the Vilnius University group at the CMS experiment at CERN;
- member of the programme committee of the 44<sup>th</sup> Lithuanian National Conference in Physics (Vilnius, Lithuania, 6-8 September, 2021).

**Dr. R. Juršėnas –**

- member of the American Mathematical Society.

**Distinguished Professor G. Juzeliūnas –**

- True member of the Lithuanian Academy of Sciences;

- Board member of Atomic Molecular Physics and Optical Division (AMOPD) of European Physical Society (2019-2022);
- Board member of Lithuanian Physics Society (since 2022);
- Associated member of the National Center for Theoretical Sciences at the National Tsing Hua University, Taiwan;
- Chairman of the Organising Committee and Member of the Programme Committee of the 14th European Conference on Atoms Molecules and Photons (Vilnius, Lithuania, June 27- July 1, 2022); <https://www.ecamp14.org/organisers>
- Member of Programme Committee of the 23-rd International Conference – School on Advanced Materials and Technologies 2021 (Palanga, Lithuania, 22 – 26 August 2022)
- Academic editor of the journal “Plos One”.

**Dr. H. R. Hamedi –**

- Member of Lithuanian Physics Society
- Member of Physics Society of Iran.

**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.

**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 the Vilnius City Physics Methodical Board;
- Team leader of Particle physics outreach group at the VU Experimental nuclear and particle physics centre;
- Chairwoman of the physics maturity exam evaluation commission;
- Member of the Lithuanian Pupil Physics Olympiad Commission;

- Council member of the Lithuanian Scientific Society.

**Dr. J. Klevas –**

- board member of the Lithuanian Astronomical Society;
- member of the International Astronomical Union (IAU);
- member of the European Astronomical Society (EAS);
- revisor of the Lithuanian Society of Young Researchers.

**Prof. A. Kučinskas –**

- member of the Board of Directors of the International Journal Astronomy and Astrophysics;
- member of the Executive Committee of the International Journal Astronomy and Astrophysics
- National Contact Point of the International Astronomical Union (IAU)
- National Representative at the European Astronomical Society (EAS)
- member of the Council of the Faculty of Physics, Vilnius University
- member of Bachelor study programme committee “Physics”
- member of Master study programme committee “Theoretical Physics and Astrophysics”
- member of the Central Appellation Commission of the Senate of Vilnius University
- member of the Organizing Committee of ChETEC-INFRA SNAQ schools
- president of the Lithuanian Astronomical Society
- member of the International Astronomical Union (IAU)
- member of the European Astronomical Society (EAS)

**Dr. M. Mackoit-Sinkevičienė –**

- member of the Board of Lithuanian Physics Society (since 2018);
- president of the European Physical Society Young Minds section in Vilnius (2016-2022 03 01), elected Member of Action Committee of EPS Young Minds (since 2022);
- representative of Lithuania in World Quantum Day Action Committee <https://worldquantumday.org/about-us/> (since 2020);
- Member of International Board at IPhO (since 2021);
- member of the Lithuanian Society of Young Researchers (since 2021).

**Dr. M. Maskoliūnas –**

- member of the International Astronomical Union (IAU).

**Dr. Š. Mikolaitis –**

- member of the International Astronomical Union (IAU);
- member of the IAU Commission “Stellar Evolution” Organising Committee;
- member of the European Astronomical Society.

**Dr. R. Minkevičiūtė –**

- member of the International Astronomical Union (IAU).

**Dr. D. Narbutis –**

- member of the International Astronomical Union (IAU).

**Prof. Dr.(HP) E. Norvaišas –**

- member of Institute of Physics;
- member of the European Physics Society.

**Dr. E. Pakštienė –**

- member of the International Astronomical Union (IAU).

**Dr. L. Radžiūtė**

- member of CompAS (The International collaboration on Computational Atomic Structure) group (<https://ddwap.mah.se/tsjoek/compas/index.php> and [CompAS | The international collaboration on Computation Atomic Structure](#))

**Dr. V. Regelskis**

- associated member of the Higher Education Academy (HEA).

**Dr. P. Rynkun**

- member of CompAS (The International collaboration on Computational Atomic Structure) group (<https://ddwap.mah.se/tsjoek/compas/index.php> and [CompAS | The international collaboration on Computation Atomic Structure](#))

**Rigonda Skorulskienė –**

- member of the Board of Lithuanian Physics Society (since 2019);
- member of the Board of the Lithuanian Astronomical Society (since 2007);
- president of the Physics Teachers' Association of Lithuania (since 2019);
- The IAU OAE NAEC (national astronomy education coordinator) team Chair and Contact Person;

**Dr. J. Sperauskas –**

- member of the International Astronomical Union (IAU).

**Dr. E. Stonkutė –**

- member of the International Astronomical Union (IAU).
- member of the European Astronomical Society.

**Dr. R. Stonkutė –**

- member of the International Astronomical Union (IAU).

**Assoc. prof. dr. Dalia Šatkovskienė –**

- Member of Administration Board (BoA) of European Platform of Women Scientists (EPWS, <https://epws.org/epws-general-assembly-2017/>);
- President of regional Baltic States association BASNET Forumas (<https://www.basnetforumas.eu/>).
- Lithuanian Team member of IUPAP working group on Women in Physics (WP5)
- CMC member of COST action CA20137 - Making Early Career Researchers' Voices Heard for Gender Equality, representing the second proposer Vilnius University.
- Represents Vilnius University in European Physicists network GENERA <https://www.genera-network.eu/>

**Dr. J. Tamulienė –**

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

**Dr. Habil. G. Tautvaišienė –**

- President of Commission H1 The Local Universe (International Astronomical Union, IAU) [https://www.iau.org/science/scientific\\_bodies/commissions/H1/](https://www.iau.org/science/scientific_bodies/commissions/H1/)
- Steering Committee Member of the IAU Division H Interstellar Matter and Local Universe [https://www.iau.org/science/scientific\\_bodies/divisions/H/](https://www.iau.org/science/scientific_bodies/divisions/H/)
- Member of Special Nominating Committee (IAU);
- President of the Lithuanian Physics Society;
- member of the International Astronomical Union (IAU);
- IAU National Outreach Coordinator <https://www.iau.org/public/noc/>;

- founding member of the European Astronomical Society;
- editorial board member of the “Mol” journal <http://mol-en.scg.org.es/editorial-board>
- editor-in-chief of the annual astronomical almanac *Lietuvos dangus (Sky of Lithuania)* <https://www.ff.vu.lt/tfai/apie/leidiniai#lietuvos-dangus>
- Chair of Organising Committee of the International Conference “Europlanet Telescope Network Science Workshop”, February 9 - 11, 2022, <http://mao.tfai.vu.lt/europlanet2022>

**Prof. Dr. V. Vansevičius –**

- member of the International Astronomical Union (IAU);
- member of the European Astronomical Society (EAS)
- member of the Research Council of Lithuania.

**Dr. J. Zdanavičius –**

- member of the International Astronomical Union (IAU).

**BEST REPORTS DELIVERED AT CONFERENCES ABROAD**

Invited talk by Gediminas Juzeliūnas “Time-dependent subwavelength optical lattices” at the International Workshop “Topology and non-equilibrium dynamics in engineered quantum systems”, Dresden, Germany, 10-14 October 2022.

Invited talk by Vidas Regelskis "Reflection equation algebras: a survey" at the 60th ARTIN meeting, Nottingham, England, 25-25 August 2022.

Oral presentation by Jonas Klevas “3D hydrodynamical model atmospheres of M-dwarfs”, XXXI General Assembly of the International Astronomical Union, Busan, South Korea, August 2-11, 2022.

Oral presentation by Gražina Tautvaišienė “Carbon and nitrogen abundances as indicators of material mixing in evolved”, at the international conference “NOT – a Telescope of the Future”, La Palma, Spain, June 7-10, 2022.

Oral presentation by Gražina Tautvaišienė “Europlanet 2024 RI: Fostering the collaboration between professional and amateur astronomers”, Europlanet Science Congress 2022, Granada, Spain, 21 September, 2022.

**THE MOST IMPORTANT RECEIVED NATIONAL AND INTERNATIONAL AWARDS FOR R&D ACTIVITIES**



Gediminas Gaigalas was awarded the Adolfas Jucys Prize of the Lithuanian Academy of Sciences for the research “Second quantization and additional symmetries in atomic physics: theory and practical applications”, 2022.02.15

Romualdas Karazija was awarded a Commemorative Medal of the Lithuanian Academy of Sciences, 2022.04.12

Vidas Regelskis was awarded the Young Mathematician Prize by the Lithuanian Mathematical Society.

Vilius Bagdonas was awarded the Stipendium of President Aleksandras Stulginskis by the Lithuanian Academy of Sciences.

### **MOST IMPORTANT PARTICIPATION CASES OF RESEARCHERS IN WORKING GROUPS OR COMMISSIONS SET UP BY STATE AUTHORITIES, STATE AND MUNICIPAL INSTITUTIONS, ORGANISATIONS, BUSINESS ENTITIES**

Prof. dr. V. Vansevičius is a member of the Research Council of Lithuania.

Doc. A. Kynienė is the chair of the Assessment of National Physics Maturity Examination Commission and a member of the education program redevelopment group.

Rigonda Skorulskienė - is a member of the Assessment of National Physics Maturity Examination Commission; a member of the education program redevelopment group; a member of working group to renew the teacher training mode

### **CONSULTATIONS PROVIDED BY THE UNIT TO THE PUBLIC OR ECONOMIC ENTITIES**

Regular consultations for various Police departments concerning astronomical conditions during the requested time periods when car accidents happened, dr. A. Kazlauskas.

Regular consultations to the public concerning unusual astronomical events and stones found which are suspected to be of extraterrestrial origin, S. Lovčikas, G. Tautvaišienė.

Regular school consultations in elementary particle physics, A. Kynienė, A. Acus, A. Juodagalvis, A. Mekys

### **MOST IMPORTANT RESEARCH DISSEMINATION ACTIVITIES**

(1) “The Sky is for Everyone. Women Astronomers in Their Own Words”, Edited by Virginia Trimble and David. A. Weintraub. ISSN: 9780691237367. Princeton University Press, 2022, p. 301, Co-author Gražina Tautvaišienė.

(2) Annual popular science edition “Lietuvos dangus 2023“, published since 1989 (ISSN 1392-0987), 154 pages in Lithuanian, Responsible editor Gražina Tautvaišienė.

(3) 2022 organization of public lectures of W. D. Phillips, winner of the Nobel Prize in Physics, at Vilnius University (Gediminas Juzeliūnas, Mažena Mackoit-Sinkevičienė). October 3rd William D. Phillips gave a lecture to the students of the Faculty of Physics of Vilnius University “*Goodbye to the Kilogram: the revolutionary reform of the modern metric system*”. October 4th William D. Phillips' gave a public lecture “*Time, Einstein and the Coolest Stuff in the Universe*” for more than 500 participants (video from the lecture: <https://www.youtube.com/watch?v=rgErE2FXCgI&t=5348s>, interview on national TV: <https://www.youtube.com/watch?v=iSxXra4HQiA&t=10s>

<https://www.lrt.lt/mediateka/irasas/2000237083/mokslo-sriuba-radioaktyviu-skystuju-atlieku-tvarkymas-ignalinos-ae-bei-interviu-su-williamu-danieliu-phillipsu>.

<https://www.15min.lt/verslas/naujiena/mokslas-it/fizikos-nobelio-laureatas-w-d-phillipsas-apie-tai-kokia-atsinaujinancios-energetikos-forma-turetu-dominuoti-ateityje-1290-1940722>

<https://www.vz.lt/inovacijos/technologijos/2022/10/10/ant-vilniuje-viesejusio-nobelio-fizikos-premijos-laureato-vizitines-korteles--1137>

(4) “2022 World Quantum Day in Lithuania” organization (Mažena Mackoit-Sinkevičienė). In Lithuania, an art competition, meetings in schools in different cities of Lithuania, and a national lecture were organized on this occasion. More than 200 participants (Lithuanians from Lithuania and abroad) took part in the “Quantum Art” competition in all age categories (from children to adults), the youngest participant was 7 years old, the oldest was 43 years old, and even young people from a special school (where children with movement disorders attend) participated. Special lecture on April 14 and a quiz was organized, for which the questions of famous Lithuanian physicists to young people were filmed (several hundred participants from different cities of Lithuania took part in the lecture). On April 25th a special event “Quantum physics in Theatre ” took place.

European Physical Society blog about World Quantum Day in Lithuania:

<https://www.eps.org/blogpost/751263/473124/World-Quantum-Day-in-Lithuania>

Lithuanian Academy of Sciences <https://www.lma.lt/index.php/1555/38/Pasaulines-kvantines-dienos-renginiai?page=news/1555/38/Pasaulines-kvantines-dienos-renginiai>

Vilnius University

<https://www.kultura.vu.lt/naujienos/1834-pasauline-kvantine-diena-vilniaus-universitete>

<https://www.ff.vu.lt/mokslo-ir-studiju-naujienos/1753-pasauline-kvantine-diena>

<http://mokslosriuba.lt/kartumesgalime/pasaulines-kvantines-dienos-lietuvoje-meno-konkursas/>

<https://www.lma.lt/index.php/1539/67/Pasauline-kvantine-diena->

<Lietuvoje?page=news/1539/67/Pasauline-kvantine-diena-Lietuvoje>

(5) In 2022 Aleksejus Kononovičius published 33 posts including 17 model simulations in the Physics of Risk blog written in English <http://rf.mokslasplus.lt/>. Majority of the posts contained a brief description of some model from econophysics or sociophysics along with an interactive implementation of the model.