

Faculty of Physics

INSTITUTE 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 (part-time), Habil. Dr. A. Bartkevičius (affiliated), Habil. Dr. R. Karazija (affiliated), Dr. A. Kučinskas (part-time), Habil. Dr. V. Straižys (Emeritus), Habil. Dr. G. Tautvaišienė (part-time), Prof. Dr. (HP) V. Vansevičius (part-time).

Research professors: Dr. E. Anisimovas (part-time), Dr. K. Černis, Dr. A. Deltuva, Prof. Habil. Dr. G. Gaigalas, Dr. (HP) V. Gontis, Doc. Dr. V. Jonauskas, Dr. H. Kjeldsen (part-time), Dr. A. Kučinskas (part-time), Habil. Dr. G. Tautvaišienė (part-time), Habil. Dr. K. Zdanavičius (affiliated).

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

Senior researchers: Doc. Dr. A. Acus, Dr. V. Dūdėnas (part-time), Dr. F. Grundahl (part-time), Dr. A. Juodagalvis, Dr. R. Juršėnas, Habil. Dr. V. Gineitytė (affiliated), Dr. D. Jurčiukonis, Dr. R. Karpuškienė, Habil. Dr. B. Kaulakys (part-time), Dr. A. Kazlauskas (affiliated), Dr. R. Kisielius, Dr. A. Kononovičius, Dr. A. Kynienė, Dr. S. Kučas, Dr. Š. Masys, Dr. Š. Mikolaitis (part-time), Prof. Dr. (HP) E. Norvaišas (affiliated), Dr. E. Pakštienė, Dr. V. Regelskis, Dr. P. Rynkun, Dr. J. Sperauskas, Dr. E. Stonkutė (part-time), Dr. J. Tamulienė, Dr. A. Vektarienė, Dr. G. Vektaris, Dr. J. Zdanavičius.

Researchers: Dr. K. Brogaard (part-time), Dr. Y. Chorniy, Dr. V. Čepas (part-time), Dr. V. Dobrovolskas (part-time), Dr. A. Drazdauskas (part-time), Dr. C. von Essen (part-time), Dr. H. R. Hamedi (part-time), Dr. R. Kazakevičius (part-time), Dr. J. Klevas (part-time), Dr. V. Kudriašov (part-time), Dr. M. Maskoliūnas, Dr. A. Mekys (part-time), Dr. A. Momkauskaitė, Dr. V. Novičenko, Dr. L. Radžiūtė, Dr. M. Mackoit-Sinkevičienė.

Research assistants: E. Kolomiecas, M. Račiūnas, S. Raudeliūnas (part-time), C. Viscasillas Vazquez, G. Žlabys (part-time).

Project-specialists: M. Ambrosch (part-time), M. Ambrozas (part-time), V. Bagdonas (part-time), S. Draukšas (part-time), M. Račiūnas (part-time), C. Viscasillas Vazquez (part-time), G. Žlabys (part-time).

Assistant professors: Dr. V. Dobrovolskas (part-time), Dr. A. Drazdauskas (part-time), Dr. V. Dūdėnas (part-time).

Teaching assistants: M. Ambrozas (part-time).

Technicians: D. Burba (part-time), E. Gvozdiovas (part-time).

Doctoral students: M. Ambrosch, M. Ambrozas, B. Bale, J. Braver., S. Draukšas, E. Kolomiecias, J. Koncevičiūtė, A. Sharma, R. Skorulskienė, R. Urbonavičiūtė.

Non-academic staff: V. Bagdonas (part-time), V. Kakarienė (part-time), B. Kavaliauskienė, 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 2021

Saulius Pakalka “Theoretical study of direct and indirect single ionisation by electron impact”. 2021/11/05.

MAIN CONFERENCES ORGANIZED IN 2021

International Europlanet Summer School “Asteroid Photometry”, Moletai Astronomical Observatory, August 16 - 27, 2021 <https://mao.tfai.vu.lt/europlanet2021>

RESEARCH PROJECTS CARRIED OUT IN 2021

Projects Supported by University Budget

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

We determined abundances of neutron-capture elements for thin- and thick-disc F, G, and K stars in several selected sky fields and compared the results with the Galactic chemical evolution models, explored elemental gradients according to stellar ages, mean galactocentric distances, and maximum heights above the Galactic plane. It was shown that the chemical age clocks are not universal at all galactocentric distances and might be not applied at all for the thick disc of the Galaxy.

Main publications:

Tautvaišienė, G., Viscasillas Vázquez, C., Mikolaitis, Š., Stonkutė, E., Minkevičiūtė, R., Drazdauskas, A., & Bagdonas, V., Abundances of neutron-capture elements in thin- and thick-disc stars in the solar neighbourhood, 2021, *Astronomy and Astrophysics*, 649, A126.

Miglio A., Chiappini C., Mackereth J. T., Davies G. R., Brogaard K., Casagrande L., Chaplin W. J., Girardi L., Kawata D., Khan S., Izzard R., Montalbán J., Mosser B., Vincenzo F., Bossini D., Noels A., Rodrigues T., Valentini M., Mandel I., Age dissection of the Milky Way discs: Red giants in the Kepler field, 2021, *Astronomy and Astrophysics*, 645, A85.

Magrini, L., Vescovi, D., Casali, G., Cristallo, S., Viscasillas Vázquez, C., Cescutti, G., Spina, L., Van Der Swaelmen, M., & Randich, S., Magnetic-buoyancy-induced mixing in AGB stars: a theoretical explanation of the non-universal relation of $[Y/Mg]$ to age, 2021, *Astronomy and Astrophysics*, 646, L2.

Star formation and dust clouds in the Orion and Perseus arms of the Galaxy. Prof. V. Straizys. 2021–2025.

Open star clusters King 7 was 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 $V = 15.5$ mag (1084 stars) and 19.5 mag (584 stars), respectively. For the stars in clusters the membership probabilities, interstellar reddenings and extinctions, distances and ages are determined. Physically the cluster is located at the outer edge of the Perseus spiral arm at $d = 2.74$ kpc, its diameter is 9.6 pc, the age is 175 ± 25 Myr, the earliest stars are of spectral classes B6-B7. The average interstellar extinction $A_V = 4.24$ mag. From the radial velocities of CO and the Galactic rotation curve we estimate distances to the nearby dust clouds TGU H989 P2 and P3 at 650-670 pc from the Sun.

Main publications

Straizys, V., Kazlauskas, A., Boyle, R.P., Janusz, R., Zdanavičius, J., Raudeliūnas S., Černis, K., Maskoliūnas, M., Macijauskas, M., Čepas V., Semionov, D. Interstellar Extinction in the Direction of the Open Cluster King 7 and New Parameters of the Cluster. *Astronomical Journal*, 2021, Volume 162, Issue 6, id.224, 11 pp.

Soam A., Andersson B.-G., Straizys V., Caputo M., Kazlauskas A., Boyle R.P., Janusz R., Zdanavičius J., Acosta-Pulido J.A. Interstellar extinction, polarization, and grain alignment in the Sh 2-185 (IC 59 and IC 63) region, *Astronomical Journal*, 2021, Volume 161, Issue 3, id.149, 17 pp.

Magneto-hydrodynamical phenomena and radiative transfer in stellar atmospheres. Prof. Dr. A. Kučinskas. 2020–2024.

We studied abundances of s-process elements Zr and Ba in the atmospheres of red giant branch stars of the Galactic globular cluster (GGC) 47 Tuc. We find that there is no connection between the synthesis of Ba and light chemical elements (such as Na, Al) in the second-generation stars in this GGC. On the contrary, the abundance of Zr is weakly correlated with that of Na. The obtained results suggest that not only the abundances of light chemical elements but also possibly those of s-process elements have been synthesized by the same polluters that enriched 2P stars with light elements. Amongst the potential candidate polluters are AGB stars ($M \sim 1.5-5 M_{\odot}$) and/or massive rotating stars ($M \sim 12 - 25 M_{\odot}$, $v_{rot} > 150$ km/s), both of which may synthesize Zr in sizeable amounts.

Main publications:

Dobrovolskas, V., Kolomicas, E., Kučinskas, A., Klevas, J., Korotin, S. Abundance of barium in the atmospheres of red giants in the Galactic globular cluster NGC 104 (47 Tuc). *Astronomy and Astrophysics*, 2021, 656, A67, 11 pp.

Kolomiecenas, E., Dobrovolskas, V., Kučinskas, A., Bonifacio, P., Korotin, S. Abundance of zirconium in the globular cluster 47 Tuc: a possible Zr-Na correlation? *Astronomy and Astrophysics*, 2021, in press.

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

Research activities were carried out in three main directions: i) studies of stellar populations in the dwarf irregular galaxy Leo A (a star sequence of peculiar metallicity was discovered in the extremely low metallicity environment); ii) studies of supermassive black holes in high-z galaxies (an effective scenario of black hole growth from stellar-mass seeds via chaotic accretion was proposed); iii) studies of star clusters in the Andromeda galaxy (a new method of adaptive cluster photometry was proposed).

Main publications:

Leščinskaitė A., Stonkutė R. & Vansevicius V. 2021, AGB and RGB stars in the dwarf irregular galaxy Leo A, *A&A*, 647, id.A170.

Naujalis R., Stonkutė R. & Vansevicius V. 2021, Deriving physical parameters of unresolved star clusters. VI. Adaptive aperture photometry of the M31 PHAT star clusters, *A&A*, 654, id.A6.

Zubovas K. & King A. 2021, High-redshift SMBHs can grow from stellar-mass seeds via chaotic accretion, *MNRAS*, 501, 4289.

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

Fifty four new asteroids have been discovered. NEO asteroids 1950 DA and Apophis were observed doing their astrometry and photometry. New precise orbits of two NEO objects were determined. We published about 9000 astrometric positions of 2100 asteroids. Near Earth Objects, TNO, 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), with the 1.8 m Vatican telescope (Mt. Graham, Arizona, U.S.A.). A new precise orbits of 106 asteroids discovered at the Vatican observatory were determined. Noctilucent clouds were observed in summer time from Vilnius station. Four asteroids were named by Kudirka, Pakštienė, Lapuška and Kėdainiai.

Main publications:

K. Černis, J. Zdanavičius, E. Pakštienė. Astrometric observations of Apophis and 43 asteroids (249 positions) in Moletai Astronomical Observatory (Code 152). M.P.C. 129112 (2021 Mar. 25).

K. Černis, R. Boyle, V. Laugalys, J. Stott. Astrometric observations of 47 asteroids (291 positions) and discovery of 7 new asteroids in Mt. Graham Observatory (Code 290). M.P.C. 127460 (2021 Jan. 27).

K. Černis, I. Eglitis. Astrometric observations of 79 asteroids (230 positions) and discovery of three new asteroids in Baldone Astrophysical Observatory (Code 069). M.P.C. 129111 (2021 Mar. 25).

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

Multiple photoionization for the K shell in the Fe atom is studied for all levels of the ground configuration. Electron-impact single ionization is investigated for the Fe³⁺ ion. The quasi-relativistic approach was used to derive spectroscopic parameters for the Ru-like tungsten ion W29+. The electronic g-tensor calculations were performed for dangling bonds – one of the most common paramagnetic defects – introduced into nanodiamonds with four different functional groups on their surfaces.

Main publications:

R. Karpuškiene, R. Kisielius. Theoretical level energies and transition data for ion W29+. Atomic Data and Nuclear Data Tables 137, 101383 (2021).

Š. Masys, V. Jonauskas, Z. Rinkevicius, Electronic g-tensor calculations for dangling bonds in nanodiamonds, J. Phys. Chem. A 125, 8249 (2021)

S. Kučas, A. Kynienė, Š. Masys, V. Jonauskas, Multiple photoionization for the K shell in the Fe atom, Astronomy & Astrophysics 654, A74 (2021).

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

The MCDHF and RCI methods were used to compute excitation energies and transition data for the 147 lowest states of the even configurations and for the 124 lowest states of the odd configurations for the P-like ions: As XIX, Kr XXII, Sr XXIV, Zr XXVI, Mo XXVIII, and W LX. E1 transition rates and weighted oscillator strengths among these states are given. Computed excitation energies and transition data are compared with the NIST recommended values and experimental or theoretical results of other authors. All calculations were performed using GRASP2018 package.

Main publications:

G. Gaigalas, P. Rynkun, L. Radžiūtė, P. Jönsson, and K. Wang. Energy and Transition Data Computations for P-like Ions: As, Kr, Sr, Zr, Mo, and W, Atomic Data and Nuclear Data Tables 141, 101428 (2021).

G. Gaigalas, S. Fritzsche. Angular Coefficients for Symmetry-Adapted Configuration States in *jj*-coupling, Computer Physics Communication 267, 108086 (2021).

L. Radžiūtė, G. Gaigalas, D. Kato, P. Rynkun, and M. Tanaka. Extended Calculations of Energy Levels and Transition Rates for Singly Ionized Lanthanide Elements. II. Tb–Yb, The Astrophysical Journal Supplement Series 257, 29 (2021).

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

Using exact scattering theory energies and widths of four-boson Efimov resonances and the fermionic dimer-atom-atom recombination rate were determined. The renormalization of the van der Waals potential in the three-atom system was studied. Selected proton-deuteron and proton-helium scattering processes were analyzed. Expressions for elementary functions were obtained for Clifford algebras $Cl(p,q)$ with $p+q < 4$. Pseudo-symmetric pairs for Kac-Moody algebras were studied. Expressions of spinorial R-matrices and Bethe vectors for deformed $SO(2n)$ - and $SO(2n+1)$ -symmetric spin chains were obtained.

Main publications:

Efimov resonances above four-boson threshold. A. Deltuva, Phys. Rev. C 103, 064001 (2021).

Recombination in the universal four-fermion system. A. Deltuva, Phys. Lett. B 820, 136599 (2021).

Van der Waals interaction as the starting point for an effective field theory. D. Odell, A. Deltuva, L. Platter, Phys. Rev. A 104, 023306 (2021).

Optical, Kinetic, and Topological Properties of Cold Atoms and Condensed Molecular Structures. Habil. Dr. G. Juzeliūnas, 2018–2021.

It is shown that a medium with a high optical depth can be used to create a system of weakly interacting Rydberg polaritons. The method of flow equations was applied to block diagonalize the extended-space Hamiltonian describing periodically modulated quantum systems. A set of benzoquinones was examined theoretically as potential electron transfer mediators in enzymatic sensor. It is shown that the A-model with equal model parameters can be considered as a Hilbert space model rather than a Pontryagin space model.

Main publications:

B. Kim, K.-T. Chen, S.-S. Hsiao, S.-Y. Wang, K.-B. Li, J. Ruseckas, G. Juzeliūnas, T. Kirova, M. Auzinsh, Y.-C. Chen, Y.-F. Chen and I. A. Yu, A weakly-interacting many-body system of Rydberg polaritons based on electromagnetically induced transparency, Commun. Phys. 4, 101 (2021).

Voitechovič E., Stankevičiūtė J; Vektarienė A., Vektaris G., Jančienė R; Kuisienė N., Razumienė J., Meškys R. Bioamperometric Systems with Fructose Dehydrogenase From *Gluconobacter japonicus* for D-tagatose Monitoring. Electroanalysis. 33, 1393-1397, (2021).

Jelena Tamulienė; Liudmila Romanova; Vasyl Vukstich; Alexander Snegursky, Fragmentation of tyrosine by low-energy electron impact, European physical journal D, vol. 75, 246 2021.

Evolution and Statistics of Complex Systems. Prof. B. Kaulakys. 2017–2021.

We have derived analytical approximations of the temporal evolution of the raw moments in the noisy voter model. We have shown that supportive interactions in the noisy voter model lead to a polarized frozen state. We have proposed a novel non-parametric goodness-of-fit test, whose output is straightforward to interpret from the information entropy perspective. The unstable delayed feedback control algorithm to effectively change the sign of the coupling constant for the weakly coupled limit cycle oscillators is presented. It is shown that the control force becomes non-invasive if our objective is stabilization of an unstable phase difference for two coupled oscillators. An overview of our models for understanding and modeling the long-range memory phenomenon in financial markets and other complex systems is presented.

Main publications:

R. Kazakevičius and A. Kononovicius. Anomalous diffusion in nonlinear transformations of the noisy voter model, *Physical Review E* 103, 032154 (2021).

A. Kononovicius. Supportive interactions in the noisy voter model, *Chaos, Solitons and Fractals* 143, 110627 (2021).

V. Novičenko and I. Ratas: Unstable delayed feedback control to change sign of coupling strength for weakly coupled limit cycle oscillators, *Chaos* 31, 093138 (2021).

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.

Using photometric and spectral observations at the Molėtai Astronomical Observatory and several other observatories, we have improved the previously established physical properties of several member stars of the Hyades stellar cluster and determined for this cluster the helium content ($Y=0.27$) and age (0.9 ± 0.1 Gyr). By using the TESS and Spitzer space telescope data, we investigated parameters of the KELT-1b and KELT 10b exoplanets. For KELT-1b, we determined the day-side temperature of about 3010 K, and the night-side temperature of about 2000 K. For KELT-10b, our results indicate a sodium detection in the planet transmission spectrum with a line contrast of 0.66% and $0.43\% \pm 0.09\%$ for the sodium DII and DI lines, respectively.

Main publications:

Brogaard, K., Pakštienė, E., Grundahl, F., Mikolaitis, Š., Tautvaišienė, G., Slumstrup, D., Talens, G. J. J., VandenBerg, D. A., Miglio, A., Arentoft, T., Kjeldsen, H., Janulis, R., Drazdauskas, A., Marchini, A., Minkevičiūtė, R., Stonkutė, E., Bagdonas, V., Fredslund Andersen, M., Jessen-Hansen, J., Pallé, P. L., Dorval, P., Snellen, I. A. G., Otten, G. P. P. L., & White, T. R., Properties of the Hyades, the eclipsing binary HD 27130, and the oscillating red giant ϵ Tauri, 2021, *Astronomy and Astrophysics*, 645, A25.

von Essen, C., Mallonn, M., Piette, A., Cowan, N. B., Madhusudhan, N., Agol, E., Antoci, V., Poppenhaeger, K., Stassun, K. G., Khalafinejad, S., & Tautvaišienė, G., TESS unveils the

optical phase curve of KELT-1b. Thermal emission and ellipsoidal variation from the brown dwarf companion along with the stellar activity, 2021, *Astronomy and Astrophysics*, 648, A71.

McCloat, S., von Essen, C., & Fieber-Beyer, S., Atmospheric Transmission Spectroscopy of Hot Jupiter KELT-10b using Synthetic Telluric Correction Software, 2021, *Astronomical Journal*, 162, 132.

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

It is shown that time and space crystalline structures can be combined together and six-dimensional time-space lattices can be realized revealing the six-dimensional quantum Hall effect quantified by the third Chern number. Also it is demonstrated that a three dimensional time-periodically driven (Floquet) lattice can exhibit chiral hinge states, and their interplay with the Weyl physics is described. The implementation of such a model is straightforward with ultracold atoms in optical superlattices.

Main publications:

G. Žlabys, C.-h. Fan, E. Anisimovas and K. Sacha, Six-dimensional time-space crystalline structures, *Physical Review B* 103, L100301 (2021)

B. Huang, V. Novičenko, A. Eckardt, G. Juzeliūnas: Floquet chiral hinge modes and their interplay with Weyl physics in a three-dimensional lattice, *Phys. Rev. B* 104, 104312 (2021).

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

We analyzed a tripod atom light coupling scheme characterized by two dark states playing the role of quasi-spin states. It was demonstrated that by properly configuring the coupling laser fields, one can create a lattice with spin-dependent sub-wavelength barriers. This allows us to flexibly alter the atomic motion and opens new possibilities for spin ordering and symmetry breaking.

Main publications:

E. Gvozdiovas, P. Račkauskas, G. Juzeliūnas, Optical lattice with spin-dependent sub-wavelength barriers, *SciPost Phys.* 11, 100 (2021).

Research group project “**Spin-orbit coupling for the generation of non-trivial quantum correlations in ultra-cold atomic systems**” funded by Research Council of Lithuania (S-LL-21-3). 2021–2024. Prof. dr. G. Juzeliūnas.

The project started in July 2021. During the first 5 months of the project we explored various possibilities of spin squeezing via the spin-orbit coupling and are planning to start writing a manuscript on this at the beginning of 2022.

Short-term research in health and education “**Feasibility study and implementation of the integrated science education in grades 5-8**” (No. P-REP-21-8) Doc. A. Kynienė, 2020 - 2021.

A consistent analysis of the achievements of students who have completed approved general education and integrated programs is carried out in accordance with the goals set in the Education Strategy. Two tests and three questionnaires were developed and discussed with teachers and school leaders. Stakeholders were provided with initial insights into the results obtained. The analysis of the received data is being continued and the preparation of a report has started.

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 the As-like ions: Se II, Br III, Kr IV, Rb V, Sr VI were obtained using MCDHF and RCI methods. Accuracy of E1 and E2-type transition properties was investigated using new methodology, based on gauge dependence. 77%–97% of E1 type transitions have D or better accuracy. 96%–98% of E2 type transitions have C or better accuracy. First four elements mainly are generated by s-process, except Sr, which is produced by r-process. This element is the first element identified in the electromagnetic spectra of two merging stars.

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 have studied the low seesaw scale in the Grimus-Neufeld model and its impact on the Lepton Flavour violating processes. We related the parameters of the scalar potential of the model to the lepton flavour violating decays and implemented the model into Flexible-SUSY program. By doing parameter scans, we put the constraints on the scalar sector of the model from the experimental limits of these decays. The results of this study will be published next year.

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.

Formation of spatially dependent electromagnetically induced transparency (EIT) patterns from pairs of Laguerre–Gauss modes has been investigated in an ensemble of cold interacting Rydberg atoms. The proposal allows for patterning Rydberg atoms at specific positions in azimuthal space, enabling single-site addressability of trapped arrays of atoms.

Main publications:

H. R. Hamedi, V. Kudriašov, N. Jia, J. Qian, and G. Juzeliūnas, Ferris wheel patterning of Rydberg atoms using electromagnetically induced transparency with optical vortex fields, *Optics Letters* 46, 4204-4207 (2021).

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.

The project started in July 2021. During the first 5 months of the project the postdoctoral fellow studied periodical driving and spin-orbit coupling for creating non-classical spin states for ultracold atoms.

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.

We will propose an approximation of a multi-state agent model with a long memory by a single variable model. Simplifying the multi-state agent model by performing a variable elimination procedure would significantly reduce the resources of digital computations and allow us to compare the results of the analyses with analytical approximations derived by ourselves or other authors. Finding analytical approximations would help make the model more accessible and user-friendly in practice.

Main publications:

R. Kazakevičius, A. Kononovicius, B. Kaulakys, V. Gontis, Understanding the Nature of the Long-Range Memory Phenomenon in Socioeconomic Systems, *Entropy* 23 (9) (2021).

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.

Barium abundance was investigated in the red giants of Galactic globular cluster 47 Tuc using the 1D NLTE spectrum synthesis. The average barium-to-iron ratio obtained agrees well with those determined in Galactic field stars at this metallicity and may therefore represent the abundance of primordial proto-cluster gas that has not been altered during the subsequent chemical evolution of the cluster.

Main publications:

Dobrovolskas, V., Kolomicas, E., Kučinskas, A., Klevas, J., Korotin, S. *Abundance of barium in the atmospheres of red giants in the Galactic globular cluster NGC 104 (47 Tuc)*, *Astronomy & Astrophysics* 656, A67 (2021).

International Research Projects

EC Horizon2020 project “**EUROPLANET2024 – Research Infrastructure**” (project No. 871149). Dr. Habil. G. Tautvaišienė. 2020 – 2023.

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. A young low-mass brown dwarf transiting a fast-rotating F-type star was discovered.

Main publications:

Marciniak, A., ... Pakštienė, E., et al., Properties of slowly rotating asteroids from the Convex Inversion Thermophysical Model, 2021, *Astronomy and Astrophysics*, 654, A87.

Benni, P., ... Pakštienė, E., et al., Discovery of a young low-mass brown dwarf transiting a fast-rotating F-type star by the Galactic Plane eXoplanet (GPX) survey, 2021, *Monthly Notices of the Royal Society*, 505, 4956.

Mieczkowska, I., Marciniak, A., Hirsch, R., Kaminski, K., Kaminska, M. K., Polinska, M., Oszkiewicz, D., Sobkowiak, K., Wróblewski, R., Zukowski, K., Pakštie, E., Ogloza, W., & Drózd, M., Serendipitous Asteroids, 2021, *Minor Planet Bulletin*, 48, 352.

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, *Astronomy and Astrophysics*, submitted.

Research Council of Lithuania. **Polish – Lithuanian Black Hole hunt** (S-LL-19-2). Dr. M. Maskoliūnas. 2019 – 2021.

Stellar evolution theory predicts there should be about 20 millions of black holes in the Milky Way galaxy in the mass range from 5 to 15 Solar Masses (e.g., Gould 2000, *ApJ*, 542,785). Yet, only a small few dozen are known from their interactions with a companion. Currently, there are no known non-interactive black holes in the Galaxy. If they are indeed present in the

numbers predicted by theory, we should discover them, however, even a non-detection will allow us to constrain the stellar evolution models.

Main publications:

Gezer, I., Zielinski, P., Wyrzykowski, L., Gromadzki, M., Kruszyńska, K., Rybicki, K., Ihanec, N., Zdanavičius, J., Maskoliūnas, M., Pakštienė, E., and Hodgkin, S., GEMINI/GMOS-S spectroscopic classification of Gaia microlensing event candidates (part 2), The Astronomer's Telegram, 2021, No. 14617.

Zielinski, P., Gezer, I., Gromadzki, M., Wyrzykowski, L., Lam, M.C., Ihanec, N., Kruszyńska, K., Rybicki, K., Zdanavičius, J., Maskoliūnas, M., Pakštienė, E., and Hodgkin, S., WTFU Transient Classification Report, No. 2021-123.

Zielinski, P., Gezer, I., Gromadzki, M., Wyrzykowski, L., Lam, M.C., Ihanec, N., Kruszyńska, K., Rybicki, K., Zdanavičius, J., Maskoliūnas, M., Pakštienė, E., and Hodgkin, S. Gaia20fnr/AT2020ably is bright microlensing event based on LT/SPRAT and Gemini/GMOS-N spectra, The Astronomer's Telegram, 2021, No. 14316.

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. The data-driven background estimation procedure for the Drell-Yan differential cross-section measurement using Run-2 CMS data was finalized. Remote DAQ general shifts on the CMS detector were taken.

New On-Shell scheme to renormalize fermion masses, fields, and mixing matrices was defined. Zbb couplings in a multi-Higgs-doublet model (MHDM) extension of the Standard Model, two-body lepton-flavour-violating decays in a two-Higgs-doublet model, and the Grimus-Neufeld model were studied.

Main publications:

Vytautas Dūdėnas, Maximilian Löschner, "Vacuum expectation value renormalization in the standard model and beyond ", Phys. Rev. D 103, 076010.

D. Jurčiukonis and L. Lavoura, “Fitting the Zbb vertex in the two-Higgs-doublet model and the three-Higgs-doublet model”, JHEP 07 (2021) 195.

International programme **Gaia-ESO Spectroscopic Survey** (ESO project 188.B-3002). Dr. Habil. G. Tautvaišienė. 2012 – 2021.

Investigations were mainly dedicated to the lithium abundance investigations. We demonstrate that the evolution of the surface abundance of Li in giant stars is a powerful tool for constraining theoretical stellar evolution models, allowing us to distinguish the effect of different mixing

processes. We find a better agreement of observed surface abundances and models with rotation-induced and thermohaline mixing. The comparison of the data with the chemical evolution model predictions favours a scenario in which the majority of the ${}^7\text{Li}$ abundance in meteorites comes from novae.

Main publications:

Magrini, L., Smiljanic, R., Franciosini, E., ... Viscasillas Vazquez, C., Bragaglia, A., Spina, L., Biazzo, K., Tautvaišienė, G., et al., The Gaia-ESO survey: Lithium abundances in open cluster Red Clump stars, 2021, *Astronomy & Astrophysics*, 655, A23.

Romano, D., Magrini, L., Randich, S., ... Tautvaišienė, G., et al., The Gaia-ESO Survey: Galactic evolution of lithium from iDR6, 2021, *Astronomy & Astrophysics*, 653, A72.

Franchini, M., Morossi, C., Di Marcantonio, P., ... Tautvaišienė, G., et al., The Gaia-ESO Survey: Oxygen Abundance in the Galactic Thin and Thick Disks, 2021, *Astronomical Journal*, 161, 9.

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 2021, computations of the first version of the M-dwarf have been completed at ITPA, a publication summarizing first scientific results is in preparation.

COST Action CA16201 "**Unravelling new physics at the LHC through the precision frontier**" (ParticleFace) (<http://particleface.eu/>). Action Chair: Dr. German Rodrigo (Valencia, Spain) (24 countries). Dr. A. Juodagalvis, Management Committee Member. 2017 – 2021.

A. Juodagalvis and T. Gajdosik attended three ParticleFace management committee on-line meetings. S. Draukšas and M. Ambrozas participated in several schools, supported by this COST Action: „Computer Algebra and Particle Physics – CAPP 2021“ (April 6-10, DESY, Hamburg), and the “Baltic School of High-Energy Physics and Accelerator Technologies 2021” (August 2-6, Klapkalnciems, Latvia). S. Draukšas gave a remote presentation in „ParticleFace webinar series“ on the 12th of October. D. Jurčiukonis visited Lisbon U. to collaborate with dr. Luís Lavoura on an extension of the Standard Model.

COST Action CA16117 „**Chemical Elements as Tracers of the Evolution of the Cosmos**” (ChETEC) (http://www.cost.eu/COST_Actions/ca/ca11617). Action Chair: Dr. Raphael Hirschi, England) (30 countries). Prof. Dr. A. Kučinskas, Managing Committee Member,

Member of the Project Core Group, Co-lead of the Working Group 3 (Astronomical Observations). 2017– 2021.

The four-year COST project CA16117 has ended in 2021. During the project duration, members of ChETEC WP3 have obtained observing time with the ESO VLT telescope for three large projects, in total >100 observing hours with UVES. Although because of ESO closure during 2020-21 because of COVID-19 some of the observations have been delayed, for the majority of projects the data have been obtained successfully and data analysis is underway.

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 online workshop MW-Gaia: Bringing the Milky Way to schools (2-4 June 2021) was organized by Vilnius University in partnership with Instituto de Astrofísica e Ciências do Espaço (Porto, Portugal). The workshop covered various topics about the Milky Way as a Galaxy: the science and research background dissemination of the GAIA science, teaching the Milky Way in schools, how to make teaching and science communication more inclusive. Gražina Tautvaišienė and Edita Stonkutė were members of Scientific Organising Committee and Šarūnas Mikolaitis was chair of the Local organising Committee. 6 invited talks, 13 contributed talks and 13 posters were in the programme. 193 participants from 52 countries were registered to attend the workshop.

COST action CA16221 project “**Quantum Technologies with Ultra-Cold Atoms**” (AtomQTech). Project Coordinator in Lithuania – Gediminas Juzeliūnas. 2017-2021.

A theoretical scheme has been investigated for creating a two-dimensional (2D) Electromagnetically Induced Grating in a three-level Λ -type atomic system interacting with a weak probe field and two simultaneous position-dependent coupling fields. It was shown that due to the azimuthal modulation of the vortex field, a 2D asymmetric grating can be obtained, giving an increase of the zeroth and high orders of diffraction, thus transferring the probe energy to the high orders of direction.

Main publications:

S. H. Asadpour, T. Kirova, J. Qian, H. R. Hamed, G. Juzeliūnas and E. Paspalakis, Azimuthal modulation of electromagnetically induced grating using structured light, *Scientific Reports* 11, 20721 (2021).

FY2021 NIFS General Collaboration Project (LHD Experiment), Japan. “**Precision spectral measurements of highly charged rare earth elements and their data analysis with nonempirical MCDF-CI calculation**” Supervisors: Prof. F. Koike and Dr. I. Murakami, research group: Prof. Dr. G. Gaigalas, Dr. Ch. Suzuki, Dr. A. Sasaki, Dr. M. Goto, Dr. D. Kato, Dr. T. Kato, Dr. H. Sakaue, 2021.

The spectral measurement of La, Pr, and Eu was continued. Combining the previously measured spectral data, atomic number dependence of the EUV and XUV spectra of lanthanide elements was analyzed in detail. A GRASP2018 package was employed for the work of the spectral line identifications. The spectrum was also compared with the available EBIT experimental data and also with the available LIBS experimental data.

Project **“Magnetic properties of nanodiamonds: Theoretical investigation”** under HPC-Europa3 Transnational Access Programme within Horizon 2020 Framework. Dr. Š. Masys. 2021.

Density functional theory calculations were performed to find out the influence of the size of nanodiamonds (NDs) on their electronic g -tensor values, with the emphasis put on the accuracy of the geometries obtained using very fast GFN2-xTB method. The observed tendencies indicate that magnetic properties of large enough NDs (~ 1.5 nm and larger) can be calculated with a good precision when their geometries are evaluated at the GFN2-xTB level, significantly reducing the computational efforts.

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.

4 million core hours were granted for a large-scale *ab initio* modeling to be performed for nanodiamonds (NDs) of different size varying from ~ 100 to ~ 1000 carbon atoms in order to assess the g -tensor dependence on the size of NDs, defect position in NDs, and surface functionalization of NDs. Point defects that are introduced into NDs – nitrogen, silicon, germanium, and nickel complexes – are exceptionally attractive for bioimaging applications.

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.

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 Astrophysics, 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;
- member of the Academic Committee, International Physics Olympiad, Vilnius, 17-25 July 2021.

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 44th Lithuanian National Conference of Physics (Vilnius, Lithuania, 6 – 8 September 2021)
- 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: Unravelling 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 -

- Committee member of the 44th Lithuanian National Conference of Physics (Vilnius, Lithuania, 6 – 8 September 2021);
- 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: Unravelling 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 44th 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 (EPS);
- Associated member of the National Center for Theoretical Sciences at the National Tsing Hua University, Taiwan;
- Chairman of the Organising 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 the Programme Committee of the 44th Lithuanian National Conference of Physics (Vilnius, Lithuania, 6 – 8 September 2021)
- Member of Programme Committee of the 23-rd International Conference – School on Advanced Materials and Technologies 2021 (Palanga, Lithuania, 23 – 27 August 2021)
- Member of the Programme Committee of the 44th Lithuanian National Conference of Physics (Vilnius, Lithuania, 6 – 8 September 2021)
- 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. Dr. 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;
- member of the Open Access Working group of the International Journal Astronomy and Astrophysics;

- president of the Lithuanian Astronomical Society;
- member of the International Astronomical Union (IAU);
- National Contact Point of the International Astronomical Union (IAU);
- member of the European Astronomical Society (EAS);
- National Representative at the European Astronomical Society (EAS);
- vice-chair/member of the Council of the Faculty of Physics, Vilnius University;
- member of the Central Appellation Commission of the Senate of Vilnius University;
- member of the Organizing Committee of ChETEC-INFRA SNAQ schools.

Dr. M. Mackoīt-Sinkevičienė –

- member of the Board of the Lithuanian Physics Society (since 2018);
- president of the European Physical Society Young Minds section in Vilnius (since 2016);
- member of the Lithuanian Society of Young Researchers (since 2021);
- Lithuanian Team Leader at the 2021 International Physics Olympiad (IPhO);
- Member of the International Board at IPhO;
- World Quantum Day Coordination Team member and representative of Lithuania
<https://worldquantumday.org/about-us/>

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” Organizing 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);
- Program committee member of the 2nd ACM International Conference on AI in Finance, <https://ai-finance.org/program-committee/>

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 the Lithuanian Physics Society (since 2019);
- member of the Board of the Lithuanian Astronomical Society (since 2007);
- president of the Physics Teachers' Association of Lithuania;
- team Chair of the IAU OAE national astronomy education coordinator team for Lithuania;
- member of the Steering Committee, International Physics Olympiad, Vilnius, 17-25 July 2021;
- Committee member of the 44th Lithuanian National Conference of Physics (Vilnius, Lithuania, 6 – 8 September 2021).

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).

Prof. V. Straižys –

- 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.

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.
- Representative of Vilnius University in the 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/
- Steering Committee Member of the IAU Division H Interstellar Matter and Local Universe 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 Europlanet Summer School “Asteroid Photometry”, Moletai Astronomical Observatory, August 16 - 27, 2021
<https://mao.tfai.vu.lt/europlanet2021>
- Program Committee member of the 44th Lithuanian National Conference of Physics (Vilnius, Lithuania, 6 – 8 September 2021)

Prof. Dr. V. Vansevičius –

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

Dr. J. Zdanavičius –

- member of the International Astronomical Union (IAU).

BEST REPORTS DELIVERED AT CONFERENCES ABROAD

Invited talk by Gediminas Juzeliūnas “Subwavelength Optical Lattices” at the Conference “VIII International School and Conference on Photonics – Photonica”, Belgrade, Serbia, 23 – 27 August 2021.

Invited talk by Gražina Tautvaišienė “Gaia-ESO Spectroscopic Survey“ at the international conference "OBA Stars: Variability and Magnetic Fields", Virtual, Sankt Petersburg, April 26 - 30, 2021.

Invited talk by Gražina Tautvaišienė “Evidences of transport processes in stellar interiors” at the international conference “HRMOS Science Workshop”, Virtual, Arcetri, Italy, October 18 - 22, 2021.

Invited plenary talk by A. Deltuva “New developments in four-nucleon reactions” at 8th Asia-Pacific Conference on Few-Body Problems in Physics, partially virtual, Kanazawa, Japan, March 1 - 5, 2021.

Invited talk by Edita Stonkutė “Europlanet Mentorship Platform for early career researchers“ at the European Astronomical Society Annual Meeting, Virtual, June 28 - July 2, 2021.

Invited talk by Gražina Tautvaišienė “The Europlanet Telescope Network: A Global Collaboration of Small Telescope Facilities” at the European Astronomical Society Annual Meeting, Virtual, June 28 - July 2, 2021.

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

Prof. V. Vansevičius is a member of the Lithuanian Science Council.

Doc. A. Kynienė is the chair of the Assessment of National Physics Maturity Examination Commission.

Rigonda Skorulskienė - is a member of the Assessment of National Physics Maturity Examination Commission and a member of the education program redevelopment group.

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

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

MOST IMPORTANT RESEARCH DISSEMINATION ACTIVITIES

Annual popular science edition “Lietuvos dangus 2022“, published since 1989 (ISSN 1392-0987), 156 pages in Lithuanian.

In 2021 we have published 33 posts in the Physics of Risk blog written in English <http://rf.mokslasplius.lt/>. Majority of the posts contained a brief description of some model from econophysics or sociophysics along with an interactive implementation of the model.

The popular science book R. Karazija “Šiuolaikinė fizika smalsiems” (Contemporary Physics for Inquisitives) was published in the series “Science for All”.

A. Momkauskaitė translated from English to Lithuanian popular science book “S. Hawking, Illustrated Brief History of Time”. It was published by Jotema Publishing House.