Astronomical Institute of the Slovak Academy of Sciences

Summary report
January 1, 2016 – December 31, 2021

Tatranská Lomnica
June 30, 2022

Questionnaire
Summary of the main activities of a research institute of the Slovak Academy of Sciences

Period: January 1, 2016 - December 31, 2021

1. Basic information on the institute:

1.1. Legal name and address

Astronomical Institute of the Slovak Academy of Sciences (AI SAS)
Tatranská Lomnica, 059 60 Vysoké Tatry, Slovak Republic

1.2. URL of the institute web site

https://www.astro.sk

1.3. Executive body of the institute and its composition

Directoriat	Name	Year of birth	Years in the position, from - to
Director	Mgr. Peter Gömöry, PhD.	1979	01.07.2019 -
Deputy director	Mgr. Marián Jakubík, PhD.	1978	01.07.2019 -
Scientific secretary	Mgr. Martin Vaňko, PhD.	1976	01.07.2019 -
Acting Director	Mgr. Peter Gömöry, PhD.	1979	01.04.2019 - 30.06.2019
Director	Mgr. Martin Vaňko, PhD.	1976	01.06.2017 - 31.03.2019
Deputy director	Mgr, Peter Gömöry, PhD.	1979	01.06.2017 - 31.03.2019
Scientific secretary	Mgr. Marián Jakubík, PhD.	1978	01.06.2017 - 31.03.2019
Director	RNDr. Aleš Kučera, CSc.	1955	01.06.2013 - 31.05.2017
Deputy director	doc. RNDr. Ján Svoreň, DrSc.	1949	01.06.2013 - 31.05.2017
Scientific secretary	Mgr. Martin Vaňko, PhD.	1976	01.07.2013 - 31.05.2017

1.4. Head of the Scientific Board

RNDr. Aleš Kučera, CSc.: 01.06.2021 –
RNDr. Luboš Neslušan, CSc.: 01.06.2017 – 31.05.2021
RNDr. Theodor Pribulla, CSc.: 01.06.2013 – 31.05.2017

1.4.1 Composition of the International Advisory Board

For the internal needs of the AI SAS, a committee for the periodic evaluation of the scientific staff is established. But the traditional way to create the committee was abandoned and new criteria for members were adopted after the last accreditation. The main goal was to form the committee that can serve also as an advisory board. Thus, well-known experts from abroad (United Kingdom, Austria and Czech Republic) and representatives from Slovak universities with a focus on astronomy and astrophysics were included to the committee. Further, department leaders, representative of the trade unions and the director of AI SAS are also members of the committee. The impact of this newly formed evaluation committee is very positive and promising for potential shaping of the future of the institute.

The actual composition of the evaluation committee is as follows:

External members

doc. RNDr. Elena Dzifčáková, DSc. – Astronomical Institute, Czech Academy of Sciences, Ondřejov, Czech Republic
prof. dr. Robertus Erdelyi – Solar Physics and Space Plasma Research Centre (SP2RC), University of Sheffield, United Kingdom
doc. RNDr. Leonard Kornoš, PhD. – Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava, Slovakia
Assoc. prof. Ernst Paunzen, Dr. – Masaryk University, Brno, Czech Republic
Assoc. prof. Mag. Manuela Temmer, Dr. rer. nat. – Institut für Physik, University of Graz, Austria
doc. RNDr. Marek Wolf, CSc. – Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic

Internal members

RNDr. Luboš Neslušan, CSc. – representative of the trade unions
Mgr. Marián Jakubík, PhD. – Department of Interplanetary Matter
Mgr. Martin Vaňko, PhD. – Stellar physics department
Mgr. Peter Gömöry, PhD. – director, Department of Solar physics

1.5. Basic information on the research personnel

1.5.1. Fulltime equivalent work capacity of all employees (FTE all), FTE of employees with university degrees engaged in research projects (FTE researchers)

2016		2017		2018		2019		2020		2021		2016-2021	
FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	average FTE all per year	average FTE researchers per year
51,28	32,96	49,52	31,58	48,68	29,53	46,54	32,33	44,10	29,26	44,64	30,04	**47,46**	**30,95**

1.5.2. If applicable, add also a short information on the merger of the institute in the evaluation period. You can also add rows in the above table corresponding to the founding institutes

Not apllicable for the AI SAS.

1.6. Basic information on the funding of the institute

1.6.1. Institutional salary budget, other salary budget[1], non-salary budget[2]

Salary budget	2016	2017	2018	2019	2020	2021	average
Institutional salary budget *[millions of EUR]*	0,776	0,875	0,860	0,981	1,069	1,055	**0,936**
Other salary budget *[millions of EUR]*	0,026	0,026	0,037	0,016	0,013	0,015	**0,022**
Total salary budget *[millions of EUR]*	0,802	0,900	0,898	0,997	1,082	1,070	**0,958**
Non-salary budget *[millions of EUR]*	0,221	0,238	0,261	0,293	0,233	0,259	**0,251**

1.7. Mission Statement of the Institute as presented in the Foundation Charter indicating the years when it was adopted and revised

The Foundation Charter of AI SAS was adopted on July 28, 2008 and it was valid until December 31, 2021. According to this Foundation Charter:

1) AI SAS is focused on observations and basic research in the group of sciences "Natural sciences", sub-group "Physical sciences", branches "Astronomy", "Astrophysics", "Plasma physics" and "Environmental Physics", with emphasis on research of the Sun, interplanetary matter, stars and stellar systems.
2) AI SAS provides consulting and other expertise services related to its main specialization.
3) AI SAS organizes the postgraduate (PhD) study in astronomy and astrophysics and ensures the participation of the institutional staff in teaching process at universities.
4) AI SAS publishes the results of its scientific activity in journals as well as in non-periodical prints and popularizes the results in media.

1.8. Summary of R&D activity pursued by the institute during the evaluation period in both national and international contexts. Describe the scientific importance and societal impact of each important result/discovery. Explain on general level – the information should be understandable for a non-specialist (recommended 5 pages, max. 10 pages for larger institutes with more than 50 average FTE researchers per year as per Table 1.5.1.)

During the evaluation period 2016-2021, AI SAS was a budgetary research institution. Thus the main source of financing was directly connected to the state budget. Currently, the institute is the principal investigator of the Centre of Excellence - Centre of space research: "Influences of the space weather". AI SAS is equipped with the modern infrastructure developed thanks to structural funds of the EU.

The AI SAS headquarters is located in Stara Lesna (Fig. 1, left panel). The institute consists of three scientific departments and an administration section. The scientific departments are: Department of Solar physics, Stellar physics department and Department of Interplanetary Matter. In this section, the scientific areas and activities, used infrastructure at both national and international level, main international collaborations and selected results are summarised for each department separately in order to provide basic information about the institute. The description of other important scientific results achieved during the evaluation period continues also in the other sections of this questionnaire shown below (mainly, section 2.1.2 provides a list of selected papers and section 2.1.8 contains a description of the important scientific results).

[1] Salary budget originating outside the regular budgetary resources of the organization, e.g. from the project funding.
[2] Includes Goods and Services and PhD fellowships

Figure 1: The main buildings of AI SAS. From left to right: headquarters at Stara Lesna, Lomnicky Stit Observatory, Skalnate Pleso Observatory.

Department of Solar physics:

The main scientific areas of the department are:

- spectroscopic and in the last years mainly spectro-polarimetric research of the photosphere and chromosphere based on data acquired by the largest solar telescopes (e.g., GREGOR, Swedish Solar Telescope, THEMIS) with very high spatial, spectral and temporal resolution in combination with the measurements taken with the newest space-born instruments during dedicated observing campaigns,
- studying of the physical events and structures in the upper solar atmosphere (e.g., filaments, coronal loops, coronal holes) based on recent satellite data (IRIS, SDO, Hinode), own measurements taken at the Lomnicky Stit Observatory (LSO), and on own observations obtained during total solar eclipses, numerical simulations of coronal structures,
- investigation of the physical properties of the most energetic events in the solar atmosphere, e.g., solar flares and coronal mass ejections, using ground-based and space data, modelling and numerical simulations of their characteristic properties.

The main observing facility run by the department is the coronal station located at the Lomnicky Stit – LSO (Fig. 1, middle panel). The LSO has a very unique role as an observatory in the European space. It is equipped with a rare double coronagraph with spectro-polarimeters and thus allows to obtain dedicated observations of the solar corona and related features (prominences, coronal dynamic events). LSO is therefore regularly involved in the complex observing campaigns together with large solar telescopes and satellites. Moreover, the observatory is an excellent place to develop, test and mount new solar instruments designed for patrol measurements (e.g., the Solar Activity Monitor – SAAMM) or for coronal observations during total eclipses (e.g., the Solar Line Emission Dopplerometer – SLED). This allows us, on the one side, to participate in the development of the newest techniques dedicated for solar observations, but it also generates opportunities to widen international collaborations of the department staff.

Next to the LSO, the department staff is very successful in applications for the observing time at the large European telescopes. Within the evaluating period, several observing campaigns led or co-organised by the department members were performed (in 2016: GREGOR campaign, SST campaign, in 2017: GREGOR+VTT campaign, in 2018: GREGOR+VTT campaign, in 2019: GREGOR campaign). The observing time was granted also for 2020 and 2021, but the campaigns were not performed because of the COVID-19 pandemic.

The very rich observing material described above is regularly combined with numerical modelling and simulations performed by the department staff. The enhanced models of prominences and dynamic jets in the upper solar atmosphere are developed. Sophisticated codes (e.g., HAZEL) are used for inversions of the spectro-polarimetric measurements taken in the chromospheric lines. This allows us to obtain original scientific results that are highly competitive in European research space and are published in the top ranked journals.

The deep integration of the department members into the international solar community is evidenced by extensive collaborations with partners from abroad. Next to several bilateral projects (see parts 2.4.1 and 2.4.6), the international acceptance of the department is manifested by the two H2020 and one FP7 projects of the European Union (see part 2.4.1). These projects provide an excellent basis for the scientific work on the European level (SOLARNET projects), but also for participation in the further development of the idea to

design and construct the European Solar Telescope – a representative of the new generation of the solar telescopes with the 4-meter aperture (PRE-EST project). Within the PRE-EST project, we even participated in one of the key initiatives defining the main scientific parameters of the telescope, called “Science Requirement Document for the European Solar Telescope”. It is important to note that next to the involvement in the EST design, the member of department participated in the definition and construction of the “Critical Science Plan for the Daniel K. Inouye Solar Telescope (DKIST – the 4-metre class solar telescope operated in the USA).
Based on the activities listed above, original and relevant results were achieved by the members of the Department of Solar Physics. Two of them are listed here (for more, see the sections 2.1.2 and 2.1.8; the item number from section 2.1.2 corresponds to the number in square brackets next to the result title below).

Properties of the inner penumbral boundary and temporal evolution of a decaying sunspot. [1]
During the last decade, the revolutionary discovery in sunspot research has proved that the intensity boundary between an umbra and a penumbra can also be described with the constant value of the vertical component of the magnetic field vector. This is known as the Jurčák criterion. To our knowledge, we provide the very first test of validating the Jurčák criterion on decaying sunspots. It was found that during the decaying phase the vertical component of the magnetic field is weaker at the umbra-penumbra boundary compared to stable sunspots, i.e., the umbra does not have a sufficiently strong vertical component of the magnetic field and is thus unstable and prone to be disintegrated by convection or magnetic diffusion (see Fig. 2). No constant value of the vertical magnetic field is found for the inner penumbral boundary.
Societal impact of the result: The research of the magnetic fine structures of the sunspots helps to understand the interaction between plasma and magnetic field. Solving this problem is a key to construct plasma devices like Tokamak and Stellarator. Thus, it can be important to gain a new source of naturally clean energy and thus completely replace fossil fuels.

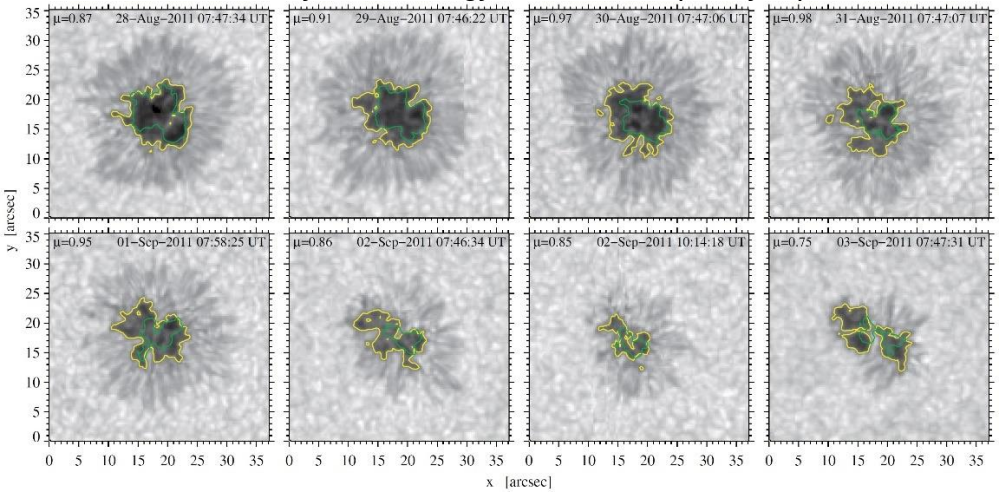

Figure 2: Temporal evolution of a sunspot. The yellow contours represent the intensity boundary between umbra and penumbra. The green contours represent visualisation of the Jurčák criterion. It is clearly seen that the Jurčák criterion does not represent umbra-penumbra boundary in the decaying sunspot.

Chromospheric evaporation flows and density changes during an M1.6 flare. [4]
Unique high-cadence sit-and-stare observations acquired with the UV space-born Hinode/EIS spectrometer and hard X-ray measurements acquired with the RHESSI satellite during an M-class flare were analysed (Fig. 3). It was found that the spectroscopic results for the flare peak are consistent with the scenario of explosive chromospheric evaporation, although a comparatively low value of the nonthermal energy flux density was determined for this phase of the flare. This outcome is discussed in the context of recent hydrodynamic simulations. It provides important observational evidence that the response of the atmospheric plasma strongly depends on the properties of the electron beams responsible for the heating, in particular the steepness of the energy distribution.
Societal impact of the result: Flares belong to the most energetic and powerful events in the solar system. Strong solar flares thus remain one of the most dangerous phenomena that faces our modern technological societies today. Improvement in the understanding of solar flares can lead to the better protection of our sensitive space instruments or electrical devices on the ground. This research helps to prevent possible significant economic losses.

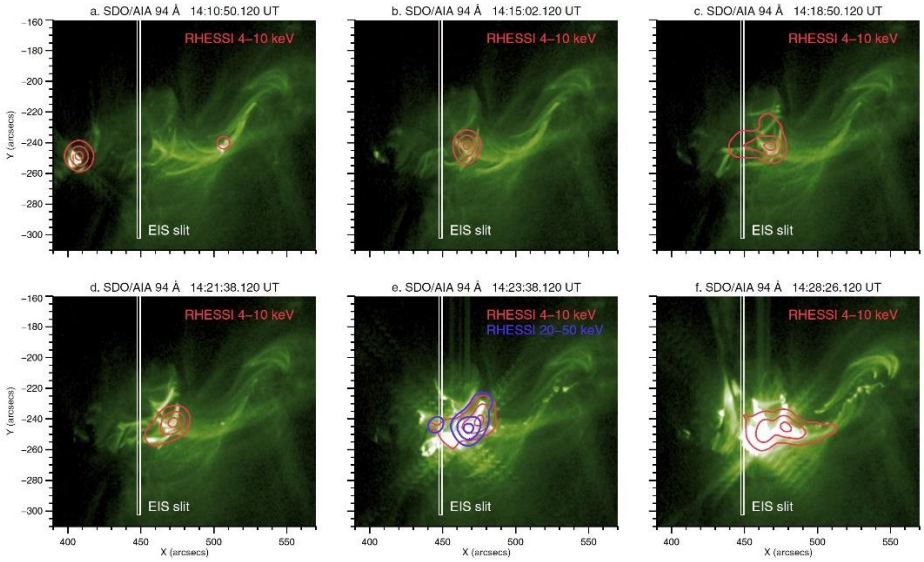

Figure 3: Temporal evolution of the solar flare under study at a temperature around 6 MK. X-ray sources are shown as contours in red (4–10 keV) and blue (20–50 keV), respectively. They show the locations of X-ray-emitting thermal plasma and nonthermal electrons, i.e., most important areas of the flaring solar atmosphere. The white rectangle depicts the lower part of the Hinode/EIS slit.

<u>Stellar physics department:</u>

The main scientific fields of the stellar department are:

- research of symbiotic stars and novae focused on the physical processes during the outburst phase: jets, accretion, envelope shedding; modelling of these phenomena based on multi-colour UBVRI photometry and échelle spectroscopy obtained with AI SAS instruments and within international collaboration, in addition archives of the satellite multi-frequency observations are used (UV data IUE, HST, FUSE; X-ray measurements: XMM-Newton, Chandra, Swift, ROSAT; IR window: ISO, Spitzer),
- investigation of eclipsing binary stars and multiple systems focused on the precise determination of the orbital elements, absolute parameters of the components, their rotation, properties of the circumstellar matter (discs, mass flows); simultaneous modelling of the photometric, spectroscopic and interferometric (VLTI, ESO) data,
- study of extrasolar planets oriented mainly on search of objects orbiting around young stars and a search for circumbinary planets (YETI and Dwarf projects); observations obtained at AI SAS are used together with the data from satellite missions (Kepler, TESS, MOST) and from the ESO instruments; modelling of peculiar objects is performed (e.g., planets with a comet-like tail, brown dwarfs), the planet-parent star interaction and the processes in close-in exoplanet atmospheres are investigated.

The main observing facility of the Stellar physics department is the 1.3 m Nasmyth-Cassegrain telescope with active optics equipped with the high-resolution échelle spectrograph (MUSICOS) located at Skalnate Pleso Observatory – SPO (Fig. 1, right panel). The telescope is used for several currently running projects, e.g., spectroscopic follow-up of planetary candidates observed by the TESS satellite; optical spectroscopy of multiple stellar systems; young T Tauri stars and symbiotic stars. The additional observing facilities of Stellar physics department were two 60 cm Cassegrain telescopes (for an important explanation see also part 3, point 2, second paragraph) equipped with the middle-resolution échelle spectrograph (eShel) and a visual UBVRI CCD camera. Direct access to our observing facilities allows us to catch and monitor the transient events as, for example, outbursts of classical novae and symbiotic stars, both photometrically and spectroscopically. Basic characteristics of the light curves of these events are thus analysed on the long-term (days to years) but also short-term scales (minutes to hours). Moreover, multi-colour photometry is used to calibrate spectroscopic observations to absolute fluxes. The combination of measurements taken at AI SAS with the satellite data and the application of the developed modelling method of the spectral energy distribution leads to precise description of the exploding events.

Recently, Stellar physics department started a collaboration with the Gothard Astrophysical Observatory in a field of extrasolar planets. The cooperation provided regular access to the

80cm remote-controlled Nasmyth-Cassegrain telescope as well as a possibility to use satellite photometric data (e.g., CHEOPS) even during a proprietary period. The department staff use the telescope to contribute to the start-up process of the CHEOPS mission, to take part in international campaigns to monitor multiple-eclipsing systems, and to study close binaries with discs. Numerous transiting exoplanets were observed to provide multi-colour photometry that is still almost lacking in cosmic missions. The results on transiting exoplanets are mainly focused on systems with rapidly rotating parent stars which show precession of the stellar spin axis and the exoplanet orbital plane.
Although Slovakia is not a member of ESO, scientists from the department obtained (in collaboration with the Observatorie of Paris and ESO) long-baseline interferometry with the GRAVITY instrument at the VLTI (Chile) in 2017. The simultaneous analysis of the interferometry and earlier MOST satellite photometry enabled us to independently test the Gaia parallaxes on a nearby eclipsing binary.
Numerous high-resolution spectroscopic observations of T Tauri stars, close binaries, and chemically peculiar stars were obtained with the Alfred Jensch 2m telescope at the Tautenburg Observatory (Germany) in 2017. These data were combined with low-resolution spectroscopic observations acquired by the 1.2 m telescope of the Asiago Observatory (Asiago).
Based on the scientific infrastructure, several significant results were published during the evaluation period. Here, two examples are provided (for more, see sections 2.1.2 and 2.1.8).

Wind mass transfer in S-type symbiotic binaries: II. Indication of wind focusing. [23]
Symbiotic stars are potential progenitors of type Ia supernovae. The ability of their white dwarfs to grow in mass is given by the accretion rate of the wind matter from their red giant companions that strongly depends on the geometrical distribution of the wind. In the case of a spherically symmetric distribution, only few percents of the wind matter escaping the red giant is transferred to the white dwarf. This amount is significantly higher for the distribution where the wind density is enhanced at the orbital plane of the binary star. The indication of the wind focusing towards the orbital plane in S-type symbiotic stars was found (Fig. 4). The resulting mass accretion rate is around an order of magnitude higher than for the spherically symmetric wind. This fact points to favourable conditions for the white dwarf to effectively grow in mass in these stellar systems.
Societal impact of the result: The supernovae, explosions of the massive stars, are the biggest explosions that humans ever observed. In the Milky Way, around two supernovae occur in each century. In the case the supernova explosion takes place close enough to Earth, a dangerous radiation can severely affect the life on our planet. The last supernova that deposited the traces of radioactive isotope iron-60 to Earth happened about 2.5 million years ago, at a distance of 150 to 300 light years away. Better knowledge of these extreme phenomena is thus important not only for a better understanding of the universe, but also for the identification of objects potentially dangerous to humanity.

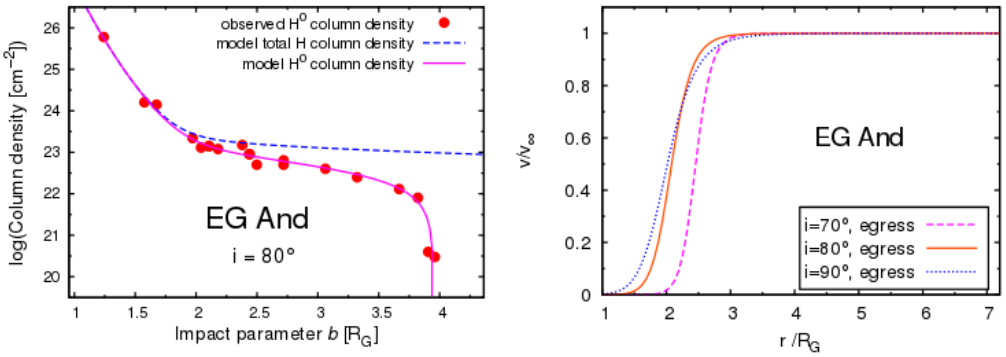

Figure 4: Left: Measured values of the column densities of neutral hydrogen around the cool giant in the symbiotic binary EG And (full circles) and their model (solid line). Right: Corresponding velocity profiles of the wind for different orbital inclinations. These results imply high values of the mass-loss rate via the wind from the giant that indicates its focusing towards the orbital plane.

Nova V339 Del: long-lasting super-Eddington luminosity with dust emission. [26]
The nova phenomenon in the constellation Delphinus (V339 Del) was investigated. The event results from the explosive thermonuclear fusion on the surface of a white dwarf (WD, a dead star with extreme gravity) after accretion of the critical amount of material from its companion in a binary system. Basically, during this process, protons create helium cores liberating the

light energy of 6.3×10^{11} Joules (= 175 000 kWh) from 1 gram of hydrogen. The original method of multiwavelength modelling of the nova spectrum (Fig. 5) was applied in this case and the new striking result was revealed: the nova generated extremely high energy (around ten times of the Eddington limit, at which the light energy balances the gravitational force of the object) and for an unexpectedly long time of the first 150 days of the nova life. This is in a strong contrast to the current theoretical prediction. Thus, the presence of an unknown physical mechanism sustaining the powerful nuclear fusion on the surface of the WD for a long time was very probably revealed.

Societal impact of the result: Determining the mechanism that maintains thermonuclear fusion with enormous energy production for a long time represents a challenging task for future developments that would ultimately solve the problem of a powerful 'green' and long-term sustainable energy source for our society, with an important by-product of minimizing reasons for wars on our Earth.

Modelling of space explosions is related also to the extreme sensitivity of the absorption of super-soft X-rays to various elements (the so-called 'absorption model'), which is not yet fully understood. Improving the absorption model from modelling space explosions will help to improve understanding of interaction between X-rays and different types of materials, leading to better X-ray devices for imaging useful, for example, for roentgenology in medicine, scanning our bags at airports an/or trucks at borders. Generally, medical imaging has a lot in common with astronomical imagery – apart from the scale.

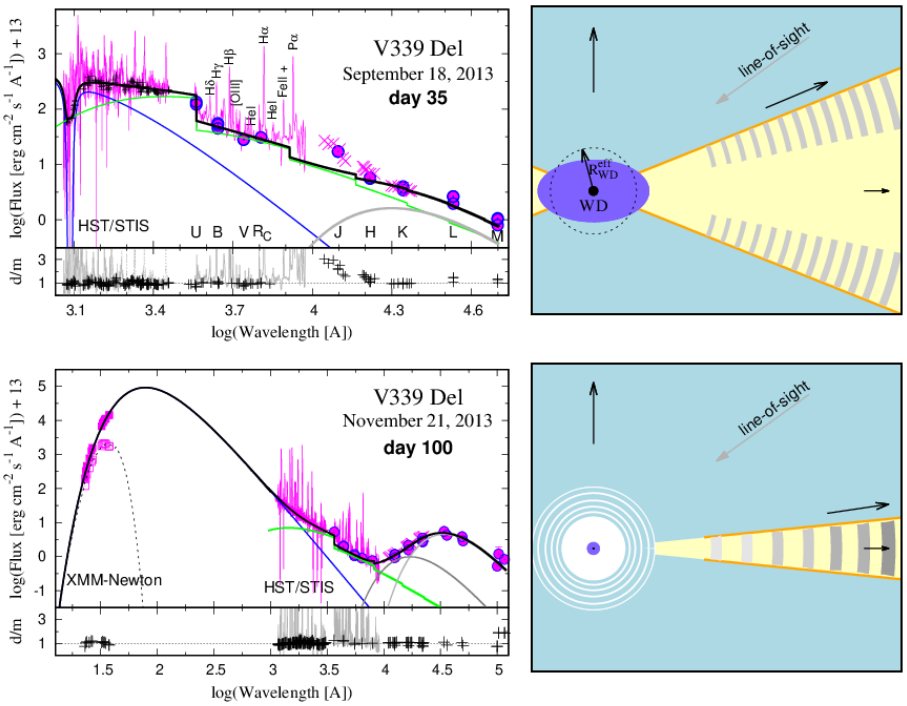

Figure 5: Left: Observed spectrum of the nova V339 Del (in magenta) and its model (black line). The model consists of the radiation from the WD (blue line), nebula (green) and dust (grey). Right: Sketch for nova ejecta. The WD pseudophotosphere is in dark-blue, stellar wind in light-blue, equatorially concentrated outflow with dust in yellow with grey strips and bow shocks as orange lines.

Department of Interplanetary Matter:

The main scientific areas of the department are:

- numerical investigation of populations of Solar System small bodies - study of transfer orbits, interrelations and evolution among different populations regarding near-Earth objects and the study of the structure of the outer part of Solar System (Edgeworth-Kuiper belt and Oort Cloud),
- photometric and spectroscopic investigation of activity of cometary nuclei and its effect on physical and dynamical evolution of comets,
- photometric research of asteroids with an accent on determination of their sizes, rotational states, shapes and other characteristics,
- study of structure and dynamics of meteoroid streams and dynamical evolution of their parent bodies, operation of the all-sky bolide cameras within the European Fireball Network,

- study of physical and chemical properties of surfaces of Solar System small bodies, simulation of effects of space weathering in laboratory conditions, formation of molecules due to ion irradiation of ices relevant to Solar System bodies.

The areas of interest listed above could be divided into two natural groups – theoretical and experimental. In addition, the experimental group consists of two different sub-groups – night observations and laboratory experiments. Each sub-group has its own requirements for research facilities.
The observational facilities run by the department are located at the Skalnate Pleso Observatory (SPO). The main, 1.3m Nasmyth-Cassegrain telescope with an active optics system is operated together with the Stellar physics department. In addition, the 61cm photometric and astrometric reflector (Newton) with a CCD camera is located in the smaller dome of SPO. The 1.3m telescope is used for high-precise photometric observations of comets to study their complex properties. The 61cm telescope is used for photometric observations of asteroids and comets. Other observational facility used by department staff members is the fully automatic Digital Bolide Camera and the fully automatic Spectral Digital Bolide Camera. Both cameras are located in Stara Lesna and they are operated in cooperation with the Astronomical Institute of the Czech Academy of Sciences (Ondřejov, Czech Republic). The cameras are incorporated in the European Fireball Network. As for numerical simulations performed in the studies of Solar System bodies dynamics, department staff members are using a 128-core CPU cluster with infiniband and/or other smaller computing servers with dedicated codes and software.
In addition to the own facilities, department staff members have access to the archives and observations at telescopes located abroad, e.g., the 6 m telescope SAO RAS (Russia), the 4.1 m SOAR telescope (Chile), the 2 m telescope p. Terskol (Russia), the 1 m telescope Sanglok (Tajikistan). Thus, additional high-quality spectroscopic observations were obtained for detailed investigation of the activity of cometary nuclei. Next to it, the laboratory experiments designed to research ices relevant to astrophysics and energy processes acting on it are performed using a new Ice Chamber for Astrophysics–Astrochemistry (ICA). ICA is a new laboratory end station located at the Institute for Nuclear Research (Atomki) in Debrecen, Hungary. In the research areas, where the numerical simulations are used, our department staff members have an access to additional computing power through distributed infrastructures (EGI, SlovakGrid, SIVVP).
An integration of department staff members into the international community takes place both formally and informally. In general, department staff members are involved in a considerable amount of collaborations (e.g., Outer Solar System Origin Survey – OSSOS) and particularly, the formal integration can be documented by the EU-funded COST project, ERASMUS+ project (see part 2.4.1) and several bilateral projects (see part 2.4.6). All formal and informal collaborations are very important, especially in the case of research areas which the department staff members are focused on - observations, laboratory experiments and large numerical simulations.

Photometry and long-split spectroscopy of the split comet C/2019 Y4 (ATLAS). [10]
The physical parameters of the comet coma during fragmentation of the nucleus were investigated. In particular, the contribution of the gaseous component to the total flow. The gaseous component showed asymmetry in the solar-antisolar direction. The fragmentation of the nucleus led to a significant increase of gas in the comet's coma. Analysis of the comet morphology in the narrowband BC, RC, and C_2 filters showed the presence of 4 fragments in the cometary coma. Moreover, a dust colour in the cometary coma was changed, from red near the nucleus (the main component of the nucleus) to very blue at a considerable distance from the nucleus. A significant difference in the colour behaviour of the coma is due to the asymmetry of the contribution of the gaseous component to the overall flow.
Societal impact of the result: The study of small bodies in the Solar System is a fundamental science, but also has a practical side. In particular, the process of formation and dynamics of aerosols of cosmic origin, the smallest meteoroid-dust component of the Solar System (sources of which are mainly comets and asteroids), and their drift to the stratosphere and lower atmosphere. The results obtained in the study of active small bodies of the Solar System complement our knowledge in the field of cloud formation and climatology, in particular, the processes of formation of mesospheric clouds and the impact on climate change.

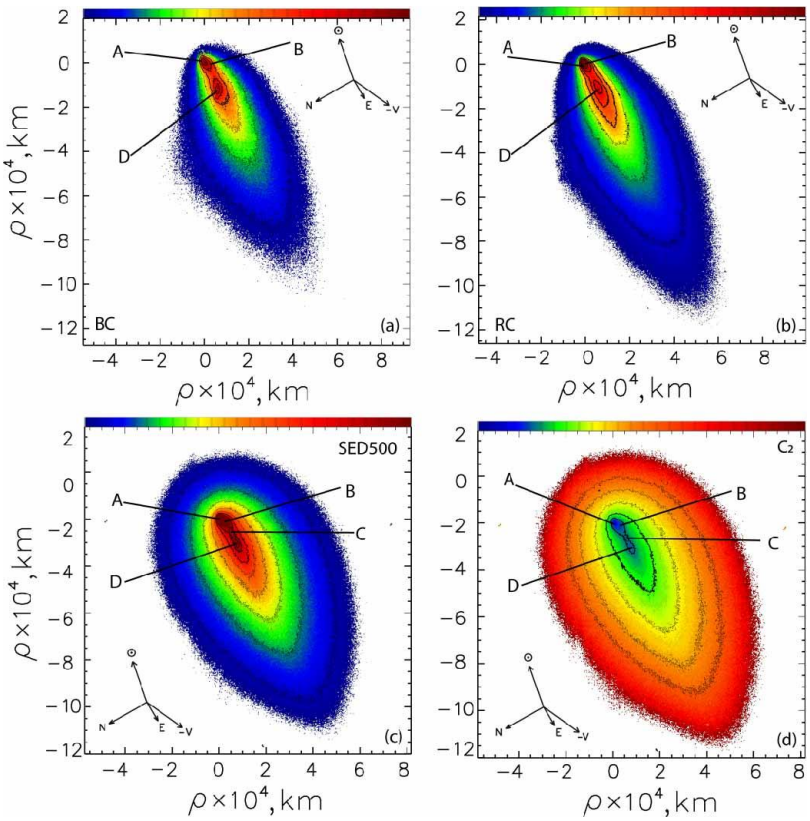

Figure 6: Images of comet C/2019 Y4 (ATLAS) acquired in the narrow-band filters: the blue continuum BC (a), the red continuum RC (b) filters, and the filter focused at the C_2 band system (c) on April 14, 2020. Diagram (d) shows the pure C_2 intensity map after the dust component subtraction. The colour scale represents brightness of the comet.

Shapes and spins of asteroids Ermolova and Silver from long-term observations. [9]

The shapes and 3D convex spin-axis models for two main-belt asteroids: (3657) Ermolova (Fig. 7) and (5325) Silver were estimated. The models were obtained with the light-curve inversion process using dense photometric data from the apparitions in 2006, 2010, and 2013 for Ermolova and in 2006, 2010, and 2013 for Silver. The analysis of the resulting data found sidereal periods and possible ecliptic pole solutions (J2000.0).

Societal impact of the result: So far, only a few asteroids and comets have been visited by unmanned probes (e.g., Hayabusa, Rosetta, Dawn). The sizes and shapes of the asteroids are essential to plan such missions. It is anticipated so even more in the future. It is known that asteroids could be good sources of minerals, they are rich in iron, nickel, iridium, cobalt, and chromium. In addition, asteroids have a higher presence of precious metals such as gold and silver and also of rare metals of the so-called platinum group (osmium, palladium, platinum, rhenium, rhodium), which are practically depleted on Earth. Thus, there is a possibility of so-called space metallurgy in the future.

Asteroids are also being considered as so-called transfer stations or transport vehicles for exploration of the deep Solar System. Simply put, a human crew would land on an object closer to Earth and it would carry the crew to the far reaches of space, saving fuel and time.

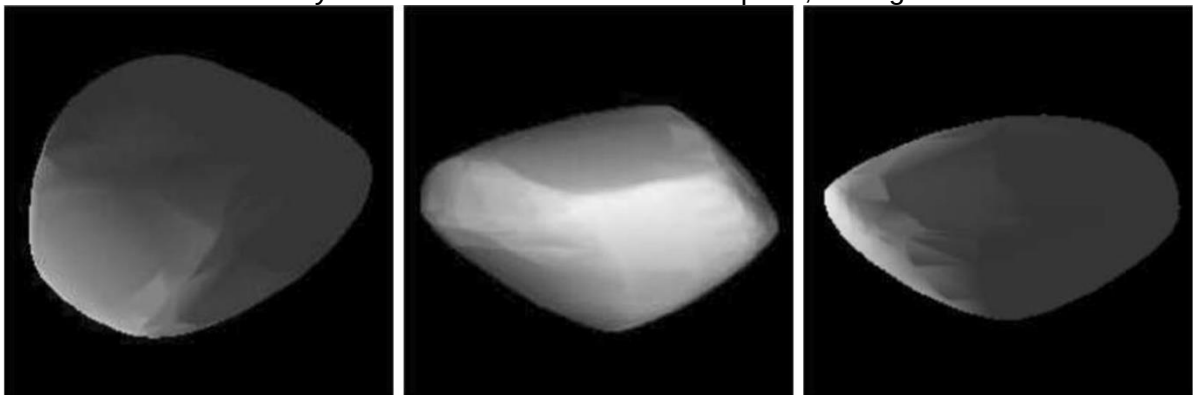

Figure 7: The shape model of the asteroid Ermolova. On the left is shown north pole view, in the middle and right the equatorial viewing and illumination geometry with rotational phases 90 degrees apart.

2. Partial indicators of main activities:

2.1. Research output

2.1.1. Principal types of research output of the institute: basic research/applied research, international/regional (in percentage)

basic research / applied research = **100 / 0**; international / regional = **100 / 0**

2.1.2. List of selected publications documenting the most important results of basic research. The total number of publications should not exceed the number of average FTE researchers per year. The principal research outputs (max. 10% of the total number of selected publications, including Digital Object Identifier – DOI if available) should be underlined. Authors from the evaluated organizations should be underlined.

The list of thirty selected publications documenting the output of AI SAS during the evaluated period is provided here. The list contains also (but not only) publications which are in details described in sections 1.8 and 2.1.8.

1) BENKO, Martin - GONZÁLEZ MANRIQUE, Sergio Javier - BALTHASAR, Horst - GÖMÖRY, Peter - KUCKEIN, Christoph - JURČÁK, Ján. Properties of the inner penumbral boundary and temporal evolution of a decaying sunspot. In Astronomy and Astrophysics, 2018, vol. 620, article no. A191, p. 1-6. (2017: 5.565 - IF, Q1 - JCR, 2.265 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201834296
2) GAJDOŠ, Pavol - VAŇKO, Martin - JAKUBÍK, Marián - EVANS, Phil - BRETTON, Marc - MOLINA, David - FERRATFIAT, Stéphane - GIRARDIN, Eric - GUDMUNDSSON, Snaevarr - SCAGGIANTE, Francesco - PARIMUCHA, Štefan. WASP-92, WASP-93, and WASP-118: transit timing variations and long-term stability of the systems. In Monthly Notices of the Royal Astronomical Society, 2019, vol. 485, no. 3, p. 3580-3587. (2018: 5.231 - IF, Q1 - JCR, 2.422 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0035-8711. Available at: https://doi.org/10.1093/mnras/stz676
3) GARAI, Zoltán. Light-curve analysis of KOI 2700b: the second extrasolar planet with a comet-like tail. In Astronomy and Astrophysics, 2018, vol. 611, article no. A63, p. 1-11. (2017: 5.565 - IF, Q1 - JCR, 2.265 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201629676
4) GÖMÖRY, Peter - VERONIG, Astrid - SU, Yang - TEMMER, Manuela - THALMANN, J.K. Chromospheric evaporation flows and density changes deduced from Hinode/EIS during an M1.6 flare. In Astronomy and Astrophysics, 2016, vol. 588, article no. A6, p. 1-12. (2015: 5.185 - IF, Q1 - JCR, 2.545 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201527403
5) GÖMÖRY, Peter - BALTHASAR, Horst - KUCKEIN, Christoph - KOZA, Július - VERONIG, Astrid - GONZÁLEZ MANRIQUE, Sergio Javier - KUČERA, Aleš - SCHWARTZ, Pavol - HANSLMEIER, Arnold. Flare-induced changes of the photospheric magnetic field in a delta-spot deduced from ground-based observations. In Astronomy and Astrophysics, 2017, vol. 602, article no. A60, p. 1-8. (2016: 5.014 - IF, Q1 - JCR, 2.234 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201730644
6) GONZÁLEZ MANRIQUE, Sergio Javier - KUCKEIN, Christoph - PASTOR YABAR, A. - DIERCKE, Andrea - COLLADOS, M. - GÖMÖRY, Peter - ZHONG, Sihui - HOU, Yijun - DENKER, Carsten. Tracking downflows from the chromosphere to the photosphere in a solar arch filament system. In The Astrophysical Journal, 2020, vol. 890, no. 1, article no. 82, p. 1-7. (2019: 5.745 - IF, Q1 - JCR, 2.144 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-637X. Available at: https://doi.org/10.3847/1538-4357/ab6cee

7) HAJDUKOVÁ, Mária, Jr. - NESLUŠAN, Luboš. Regular and transitory showers of comet C/1979 Y1 (Bradfield). In Astronomy and Astrophysics, 2017, vol. 605, article no. A36, p. 1-13. (2016: 5.014 - IF, Q1 - JCR, 2.234 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201730646
8) HAMBÁLEK, Ľubomír - VAŇKO, Martin - PAUNZEN, Ernst - SMALLEY, B. T Tauri stars in the SuperWASP and NSVS surveys. In Monthly Notices of the Royal Astronomical Society, 2019, vol. 483, no. 2, p. 1642-1654. (2018: 5.231 - IF, Q1 - JCR, 2.422 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0035-8711. Available at: https://doi.org/10.1093/mnras/sty3151
9) HUSÁRIK, Marek. Lightcurve analysis, shapes and spins of asteroids Ermolova and Silver from long-term observations. In Earth, Moon, and Planets, 2016, vol. 119, p. 35-45. (2015: 0.659 - IF, Q4 - JCR, 0.328 - SJR, Q3 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0167-9295. Available at: https://doi.org/10.1007/s11038-016-9498-x
10) IVANOVA, Oleksandra - LUKYANYK, Igor V. - TOMKO, Dušan - MOISEEV, Alexei. Photometry and long-split spectroscopy of the split comet C/2019 Y4 (ATLAS). In Monthly Notices of the Royal Astronomical Society, 2021, vol. 507, no. 4, p. 5376-5389. (2020: 5.287 - IF, Q1 - JCR, 2.058 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0035-8711. Available at: https://doi.org/10.1093/mnras/stab2488
11) IVANOVA, Oleksandra - ROSENBUSH, Vera - LUKYANYK, Igor V. - KOLOKOLOVA, Ludmilla O. - KLESHCHONOK, Valerii - KISELEV, Nikolai - AFANASIEV, Viktor - KIRK, Zachary Renée. Observations of distant comet C/2011 KP36 (Spacewatch): photometry, spectroscopy, and polarimetry. In Astronomy and Astrophysics, 2021, vol. 651, article no. A29, p. 1-22. (2020: 5.803 - IF, Q1 - JCR, 2.137 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/202039668
12) KAŇUCHOVÁ, Zuzana - URSO, Riccardo Giovanni - BARATTA, Giuseppe Antonio - BRUCATO, John R. - PALUMBO, Maria Elisabetta - STRAZZULLA, Giovanni. Synthesis of formamide and isocyanic acid after ion irradiation of frozen gas mixtures. In Astronomy and Astrophysics, 2016, vol. 585, article no. A155, p. 1-8. (2015: 5.185 - IF, Q1 - JCR, 2.545 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201527138
13) KARLICKÝ, Marian - RYBÁK, Ján. The 2017 September 6 flare: Radio bursts and pulsations in the 22-5000MHz range and associated phenomena. In The Astrophysical Journal Supplement Series, 2020, vol. 250, no. 2, article no. 31, p. 1-14. (2019: 7.950 - IF, Q1 - JCR, 3.335 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0067-0049. Available at: https://doi.org/10.3847/1538-4365/abb19f
14) KOZA, Július - KURIDZE, David - HEINZEL, Petr - JEJČIČ, Sonja - MORGAN, Huw - ZAPIÓR, M. Spectral diagnostics of cool flare loops observed by the SST. I. Inversion of the Ca II 8542 A and H-beta lines. In The Astrophysical Journal, 2019, vol. 885, no. 2, article no. 154, p. 1-13. (2018: 5.580 - IF, Q1 - JCR, 2.741 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-637X. Available at: https://doi.org/10.3847/1538-4357/ab4426
15) MALIUK, Andrii - BUDAJ, Ján. Spatial distribution of exoplanet candidates based on Kepler and Gaia data. In Astronomy and Astrophysics, 2020, vol. 635, article no. A191, p. 1-13. (2019: 5.636 - IF, Q1 - JCR, 2.174 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201936692
16) NESLUŠAN, Luboš - VAUBAILLON, Jeremie - HAJDUKOVÁ, Mária, Jr.. A study to improve the past orbit of comet C/1917 F1 (Mellish) on the basis of its meteor showers. In Astronomy and Astrophysics, 2016, vol. 589, article no. A100, p. 1-10. (2015: 5.185 - IF, Q1 - JCR, 2.545 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201527526
17) NESLUŠAN, Luboš - BUDAJ, Ján. Mysterious eclipses in the light curve of KIC8462852: a possible explanation. In Astronomy and Astrophysics, 2017, vol. 600, article no. A86, p. 1-20. (2016: 5.014 - IF, Q1 - JCR, 2.234 - SJR, Q1 - SJR,

Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201629344

18) ORTIZ, J. L. - SANTOS-SANZ, P. - SICARDY, Bruno - BENEDETTI-ROSSI, G. - BERARD, D. - MORALES, N. - DUFFARD, R. - BRAGA-RIBAS, F. - HOPP, U. - RIES, Christoph - NASCIMBENI, V. - MARZARI, F. - GRANATA, V. - PÁL, A. - KISS, C. - PRIBULLA, Theodor - KOMŽÍK, Richard - HORNOCH, Kamil - PRAVEC, Petr - BACCI, Paolo – et al. The size, shape, density and ring of the dwarf planet Haumea from a stellar occultation. In Nature, 2017, vol. 550, no. 7675, p. 219-223. (2016: 40.137 - IF, Q1 - JCR, 18.389 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0028-0836. Available at: https://doi.org/10.1038/nature24051
19) PRIBULLA, Theodor - PUHA, E. - BORKOVITS, T. - BUDAJ, Ján - GARAI, Zoltán - GUENTHER, E. - HAMBÁLEK, Ľubomír - KOMŽÍK, Richard - KUNDRA, Emil - SZABÓ, Gy. M. - VAŇKO, Martin. Secular changes in the orbits of the quadruple system VW LMi. In Monthly Notices of the Royal Astronomical Society, 2020, vol. 494, no. 1, p. 178-189. (2019: 5.356 - IF, Q1 - JCR, 1.937 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0035-8711. Available at: https://doi.org/10.1093/mnras/staa699
20) PRIKRYL, Paul - NIKITINA, Lidia - RUŠIN, Vojtech. Rapid intensification of tropical cyclones in the context of the solar wind-magnetosphere-ionosphere-atmosphere coupling. In Journal of Atmospheric and Solar-Terrestrial Physics, 2019, vol. 183, p. 36-60. (2018: 1.790 - IF, Q3 - JCR, 0.633 - SJR, Q2 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 1364-6826. Available at: https://doi.org/10.1016/j.jastp.2018.12.009
21) RUŠIN, Vojtech - PRIKRYL, Paul - PRIKRYL, Emil A. White-light solar corona structure observed by naked eye and processed images. In Monthly Notices of the Royal Astronomical Society, 2020, vol. 495, no. 2, p. 2170-2178. (2019: 5.356 - IF, Q1 - JCR, 1.937 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0035-8711. Available at: https://doi.org/10.1093/mnras/staa1377
22) SANIGA, Metod - HOLWECK, Frédéric - JAFFALI, Hamza. Taxonomy of three-qubit Mermin pentagrams. In Symmetry-Basel, 2020, vol. 12, no. 4, article no. 534, p. 1-7. (2019: 2.645 - IF, Q2 - JCR, 0.365 - SJR, Q2 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 2073-8994. Available at: https://doi.org/10.3390/SYM12040534
23) SHAGATOVA, Natalia - SKOPAL, Augustín - CARIKOVÁ, Zuzana. Wind mass transfer in S-type symbiotic binaries : II. Indication of wind focusing. In Astronomy and Astrophysics, 2016, vol. 588, article no. A83, p. 1-10. (2015: 5.185 - IF, Q1 - JCR, 2.545 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201525645
24) SHANKMAN, Cory - KAVELAARS, J.J. - BANNISTER, Michele T. - GLADMAN, Brett J. - LAWLER, Samantha - CHEN, Ying-Tung - JAKUBÍK, Marián - KAIB, Nathan - ALEXANDERSEN, Mike - GWYN, Stephen D. J. - PETIT, Jean-Marc - VOLK, Kathryn. OSSOS. VI. Striking biases in the detection of large semimajor axis trans-Neptunian objects. In The Astronomical Journal, 2017, vol. 154, article no. 50, p. 1-8. (2016: 2.609 - IF, Q2 - JCR, 2.511 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6256. Available at: https://doi.org/10.3847/1538-3881/aa7aed
25) SHUGAROV, Sergey - KATYSHEVA, Natalia A. - CHOCHOL, Drahomír - KRUSHEVSKA, Victoria - VOZYAKOVA, O. V. Superhump and outburst activity of the cataclysmic variable RZ LMi in the U - and optical passbands. In Astrophysics and Space Science, 2018, vol. 363, article no. 100, p. 1-7. (2017: 1.885 - IF, Q3 - JCR, 0.616 - SJR, Q3 - SJR, Current Contents - CCC). (2018 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-640X. Available at: https://doi.org/10.1007/s10509-018-3299-9
26) SKOPAL, Augustín. Multiwavelength modeling of the SED of Nova V339 Del: Stopping the wind and long-lasting super-Eddington luminosity with dust emission. In The Astrophysical Journal, 2019, vol. 878, no. 1, article no. 28, p. 1-18. (2018: 5.580 - IF, Q1 - JCR, 2.741 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-637X. Available at: https://doi.org/10.3847/1538-4357/ab1f07
27) SCHWARTZ, Pavol - GUNÁR, Stanislav - JENKINS, J. M. - LONG, D. M. - HEINZEL, Petr - CHOUDHARY, D. P. 2D non-LTE modelling of a filament

observed in the H alpha line with the DST/IBIS spectropolarimeter. In Astronomy and Astrophysics, 2019, vol. 631, aricle no. A146, p. 1-12. (2018: 6.209 - IF, Q1 - JCR, 2.527 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201935358

28) SVOREŇ, Ján - KAŇUCHOVÁ, Zuzana. Orionids and Eta Aquariids in the IAU MDC database. In Planetary and Space Science, 2017, vol. 143, p. 138-141. (2016: 1.892 - IF, Q3 - JCR, 1.207 - SJR, Q2 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0032-0633. Available at: https://doi.org/10.1016/j.pss.2016.10.016
29) TOMKO, Dušan - NESLUŠAN, Luboš. Meteoroid-stream complex originating from comet 2P/Encke. In Astronomy and Astrophysics, 2019, vol. 623, article no. A13, p. 1-24. (2018: 6.209 - IF, Q1 - JCR, 2.527 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201833868
30) VAŇKO, Martin - TORRES, Guillermo - HAMBÁLEK, Ľubomír - PRIBULLA, Theodor - BUCHHAVE, L. - BUDAJ, Ján - DUBOVSKÝ, Pavol - GARAI, Zoltán - GINSKI, Christian - GRANKIN, K. - KOMŽÍK, Richard - KRUSHEVSKA, Victoria - KUNDRA, Emil - MARKA, Claudia - MUGRAUER, Markus - NEUHÄUSER, Ralph - OHLERT, Johannes - PARIMUCHA, Štefan - PERDELWITZ, V. - RAETZ, Stefanie - SHUGAROV, Sergey. On the nature of the candidate T-Tauri star V501 Aurigae. In Monthly Notices of the Royal Astronomical Society, 2017, vol. 467, p. 4902-4913. (2016: 4.961 - IF, Q1 - JCR, 2.388 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0035-8711. Available at: https://doi.org/10.1093/mnras/stx407

2.1.3. List of monographs/books published abroad

1) BUDAJ, Ján - KABÁTH, Petr - PALLÉ, Enric. Extrasolar enigmas: From disintegrating exoplanets to exoasteroids. In *Reviews in Frontiers of Modern Astrophysics: From Space Debris to Cosmology*. - Cham : Springer Nature Switzerland AG, 2020, p. 45-78. ISBN 978-3-030-38508-8.

2.1.4. List of monographs/books published in Slovakia

1) NESLUŠAN, Luboš. *Elementárny úvod do nebeskej mechaniky*. Bratislava : VEDA, vydavateľstvo SAV, 2017. 336 s. ISBN 978-80-224-1610-8

2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items for institute with less than 50 average FTE researchers per year, 20 for institutes with 50 – 100 average FTE researchers per year and so on

1) AI SAS maintains and regularly updates the IAU MDC database of precise meteor orbits and meteor showers. The database is publicly accessible directly via https://www.iaumeteordatacenter.org,
2) AI SAS operates camera stations installed in Stara Lesna (the Digital Bolide Camera and the Spectral Digital Bolide Camera) and the Kolonica observatory to continuously observe bright meteors (bolides) and potential meteorite falls; the two additional bolide stations located in the Rimavska Sobota observatory and the Hurbanovo observatory are operated in collaboration with the Astronomical Institute, Czech Academy of Sciences, all the camera stations are part of the European Fireball Network,
3) AI SAS provides a long term catalogue of H-alpha prominences based on coronagraphic observations from the Lomnicky Stit Observatory and on full disk H-alpha images taken at the Kanzelhöhe Observatory, University of Graz, Austria,
4) AI SAS (the 1.3m telescope at Skalnate Pleso) is included in the Europlanet Telescope Network project and acts as an NA2 Science Advisory Panel (comets) coordinator.
5) AI SAS provides free software packages: Pyshellspec – an advanced astrophysical tool for modelling of binary systems with circumstellar matter (e.g. accretion disk, jet, shell); Shellspec - a long-characteristic LTE radiation transfer code, ROCHE – multi-dataset modelling of the close eclipsing binaries,

6) AI SAS participated in the creation of one of the key documents defining the main scientific parameters of the European Solar Telescope, so called “Science Requirement Document for the European Solar Telescope“, The project of the European Solar Telescope is included in the ESFRI – European Strategy Forum on Research Infrastructures.
7) AI SAS has been involved in the Outer Solar System Origins Survey (OSSOS) - the highest-priority Large Program on the 3.6m Canada-France-Hawaii Telescope (Mauna Kea).
8) AI SAS is involved in the first Slovak Roadmap for Research Infrastructures – SK VI Roadmap 2020 – 2030 as a coordinator of the EST project in Slovakia.
9) AI SAS has been involved in an international campaign of ground-based observations of the comet supporting the Rosetta mission.

2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad

AI SAS is the organization focused exclusively on basic research and therefore it has no patents.

2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia

AI SAS is the organization focused exclusively on basic research and therefore it has no patents.

2.1.8. Narrative on the most important research outputs of the institute – especially focused on their importance for society (3-5 pages)

We continue with the description of the most relevant scientific results achieved at AI SAS during the evaluation period here. Part of the results is already described in the section 1.8.

Spatial distribution of exoplanet candidates based on Kepler and Gaia data. [15]
The occurrence of planets in different environments in our Galaxy was studied for the first time. It was found that the distribution of planets is almost homogeneous in our Galactic neighbourhood and in the vicinity of open clusters where stars are born. It means that our Solar System is not located at any special place in the Galaxy and our neighbourhood may be teeming with planets and extra-terrestrial civilizations.

Mysterious eclipses in the light curve of KIC8462852: a possible explanation. [17]
KIC 8462852, a star that shows unexpected and sudden drops in its brightness like no other star was studied. There was no simple explanation of this behaviour and it was seriously suggested that it might be due to an extra-terrestrial civilization harbouring energy from the star. Many people and significant resources were devoted to search for further evidence of this civilization. Our detailed study showed that such behaviour might be due to dust clouds occulting the star and it may not be necessary to invoke an alien civilization and hence spend too many resources on this star.

KOI 2700b: the second extrasolar planet with a comet-like tail. [3]
One of the open questions, related to planetary formation and evolution is the possible catastrophic evaporation of rocky planet bodies. From the viewpoint of the future of mankind it is important to know, whether this scenario is possible or not in the case of the planet Earth. It was confirmed that this scenario is possible, only if the planet’s size is smaller than the size of the planet Mercury, and if the planet body receives significant energy from its host star, i.e., the planet is on a close-in orbit, which is definitely not the case of Earth.

Transit timing variations and long-term stability of the extra-solar systems. [2]
In recent years, an increasing number of planetary systems was found. In order to understand their properties, it is necessary to study planetary systems in terms of stability and dynamics. The long-term numerical simulations were used to

successfully identify stable regions where another potential planet of the particular systems under study could exist for a long time.
Societal impact of the results above: The question of the existence, evolution, and fate of life is inevitably connected to the existence and evolution of planets. Can planets and hence extra-terrestrial civilizations be found anywhere in the Galaxy? Where to look for them? Addressing these questions is extremely important and interesting for a public. On the other hand, until the discovery of first extra-solar planets in 1992 and 1995 our only laboratory to study the formation and evolution of planets and origin of life was our own Solar System. Since that time thousands of exoplanets have been detected and it turned out that many theories of the origin of planets and life and their fate were wrong and need to be revisited. Study of extra-solar planets is thus inevitable for understanding of our own origin.

Regular and transitory showers of comet C/1979 Y1 (Bradfield). [7]
It was found that the modelled stream of C/1979 Y1 approaches the Earth's orbit in two filaments that correspond to two regular (annual) showers. The generic relationship between the studied parent comet and 175 July Pegasids was confirmed. The other predicted shower is a daytime shower with the mean radiant situated symmetrically to the July Pegasids with respect to the apex of the Earth's motion. This shower is not in the IAU MDC list, but it was separated from the Cameras-for-Allsky-Meteor-Surveillance (CAMS) and SonotaCo video data as a new shower. It was suggested to name it α-Microscopiids.
Meteoroid-stream complex originating from comet 2P/Encke. [29]
The modelled stream of 2P/Encke approaches the Earth's orbit in several filaments with the radiant areas grouped in four cardinal directions of ecliptical showers. These groups of radiant areas are situated symmetrically with respect to the apex of the Earth's motion around the Sun. In addition to the already known, five new showers related to the 2P/Encke comet were discovered.
Orionids and Eta Aquariids in the IAU MDC database. [28]
The structure of the Orionids and the Eta Aquariids meteor streams was studied using the IAU MDC Photographic Orbits Database. Both the streams are associated with one of the most active comet known in the cometary population, i.e., 1 P/Halley. The stream is constantly supplemented by new particles, what creates conditions for a formation of a complex internal structure. It was found that two frequency maxima of the photographic Orionids coincide with the positions of the maximum activity of the visual meteors and bolides. It was also shown that Eta Aquariids are in fact the core of the stream while the orbits of Orionids are much further from the cometary orbit.
Societal impact of the results above:
Systematic monitoring of the near-Earth space and the associated risk of meteoroids impacting spacecraft (which are performed by programmes like NASA's Meteoroid Environment Office) is important. The meteoroid particles erode the artificial satellites and threaten the space ships with human crews. Hence, it is important to know the occurrence of meteoroid particles in the vicinity of our planet, the directions from which the particles come in a given season of year, and the dynamics of their sources (i.e., the parent bodies). Each new piece of information on the meteoroid environment can be used to identify areas of increased occurrence of potential micrometeorites in space and reduce the risk of critical damage to manned space stations.

Synthesis of formamide after ion irradiation of frozen gas mixtures. [12]
Laboratory experiments in which ice mixtures (H_2O:CH_4:N_2, H_2O:CH_4:NH_3, and CH_3OH:N_2) were bombarded with energetic ions (H^+ or He^+) have been performed. FTIR spectroscopy was performed before, during, and after the ion bombardment. In particular, the formation of HNCO and NH_2HCO (formamide) was measured quantitatively. It was suggested that energetic processing of ices in the pre- and proto-stellar regions and in comets is the main mechanism to produce formamide.

Societal impact of the result: Formamide is an alternative solvent to water. Thus, the possibility that formamide has the ability to support life with alternative biochemistries to that currently found on Earth was proposed. It forms by the hydrolysis of hydrogen cyanide. In addition, formamide can convert to traces of guanine upon heating in the presence of UV light. Some hypothesis assumes that formamide can play essential role in the origin of life.

Distant comet C/2011 KP36: photometry, spectroscopy, polarimetry. [11]
Two strong jet-like structures in solar and antisolar directions and two short and narrow jet features in the perpendicular direction were revealed in the coma. Our simulations showed that the latter two jets originated from the same active area. We determined the orientation of the rotation axis of the nucleus and the position of three active areas. The comet was found to be rich in CO^+, while there was no clear detection of CN, C_3, C_2, and N_2^+.
Societal impact of the result: Amino acids are the basic building blocks of life because they are the basic building blocks of proteins, the molecules that control cells. Terrestrial life builds on 20 different amino acids to make millions of different proteins. For the first time, life-critical compounds, including the amino acids glycine and phosphorus, were directly detected in comets 81P/ Wild-2 and 67P/Churyumov-Gerasimenko. The presence of glycine, phosphorus, and other organic molecules in comets, as well as their study, can play a crucial role in the origin of life on Earth

2D non-LTE modelling of a solar filament. [27]
Changes in the physical properties of the filament plasma preceding the eruption were studied. The filament was in the state of activation and it erupted approximately 24 hours later. The model of the filament based on radiative transfer in hydrogen plasma in the two-dimensional geometry calculated under departure from the local thermodynamical equilibrium was used. Synthetic profiles of the Hα spectral line calculated by the model were compared with the observed ones for diagnostics of the filament plasma. Results of the modelling showed that while one part of the filament was cooler, denser and more dynamic, its other part was hotter, less dense and almost without any dynamics. These results indicate that filaments are activated non-uniformly before their eruptions.
Rapid intensification of tropical cyclones in the context of the solar wind-magnetosphere-ionosphere-atmosphere coupling. [20]
Rapid intensification of tropical storms was examined in the context of solar wind coupling to the magnetosphere-ionosphere-atmosphere system. The results indicate that rapid intensification of tropical storms tends to follow arrivals of high-speed streams from coronal holes or interplanetary coronal mass ejections, which can trigger geomagnetic storms.
Spectral diagnostics of cool flare loops [14]
Flare loops form an integral part of eruptive events, being detected in the range of temperatures from X-rays down to cool chromospheric-like plasmas. While hot loops are routinely observed, cool loops seen off-limb are rare. Rare ground-based observations were used to study thermodynamical parameters of such cool loops, mainly the electron densities. The values of 10^{12} cm^{-3} were found. The presence of such high densities in solar eruptive flares supports the loop interpretation of the optical continuum emission of stars which manifest superflares.
Flare-induced changes of the photospheric magnetic field in a delta-spot. [5]
The active region of high flaring activity was investigated. It was shown that after the M-class flare, the longitudinal magnetic field in the photosphere did not show significant changes along the polarity inversion line (PIL). However, an enhancement of the transverse magnetic field of approximately 550 G was found that bridges the PIL and connects umbrae of opposite polarities in the δ-spot. At the same time, a newly formed system of loops appeared co-spatially in the corona. However, it was not possible to exclude that the magnetic connection between the

umbrae already existed in the upper atmosphere before the M-class flare and became visible only later when it was filled with hot plasma.
Societal impact of the results above:
The eruptive solar events have remarkable impact on space weather. They significantly affect Earth's magnetosphere causing the so-called magnetic storms. Magnetic storms can be real danger for telecommunication satellites, long electricity lines, electronics in planes during intercontinental flights and can also cause interruptions in the short-wave radio connection in the ship transportation or loss of GPS signals. In addition, it has been shown that the sudden intensification of tropical storms follows about 2-4 days after the arrival of high-speed solar wind particles. The understanding of solar flares and coronal mass ejections is therefore crucial nowadays.

Taxonomy of three-qubit Mermin pentagrams. [22]
The two remarkable classes of observable-based quantum contextual configurations located in the three-qubit symplectic polar space were fully classified. The classification intricately combines the character of three-qubit observables with the properties of positive/negative-valued Fano planes of the associated symplectic polar space and reveals important finer structure of three-qubit (observable-based) quantum contexts. We believe that such classification can be of relevance in any branch of quantum information theory (quantum protocols) where the Mermin pentagram is a key element.
Societal impact of the results above:
The quantum contextuality has recently been investigated as a source of quantum advantage and computational speedups in quantum computing which is, for example, supposed to: lead to much stronger protection of our digital lives and assets, enable much more complex computer modelling like aeronautical scenarios, better predict and forecast various weather scenarios that rely on large and complex data sets, and have also significant implications for the future of military sensing, encryption, and communications.

2.1.9. Table of research outputs

Papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. /1 million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	1	0,034	0,924	0	0,000	0,000	**1**	**0,167**	**0,005**	**0,174**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*	0	0,000	0,000	1	0,032	1,111	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	**1**	**0,167**	**0,005**	**0,174**
Chapters in scientific monographs published abroad *(ABC)*	0	0,000	0,000	0	0,000	0,000	**1**	0,034	1,114	2	0,062	2,005	0	0,000	0,000	0	0,000	0,000	**3**	**0,500**	**0,016**	**0,522**
Chapters in scientific monographs published in Slovakia *(ABD)*	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	**0**	**0,000**	**0,000**	**0,000**
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	34	1,032	42,375	47	1,488	52,216	38	1,287	42,327	36	1,114	36,096	52	1,777	48,070	44	1,465	41,121	**251**	**41,833**	**1,352**	**43,657**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above *(ADMA, ADMB, ADNA, ADNB)*	5	0,152	6,232	7	0,222	7,777	6	0,203	6,683	19	0,588	19,051	10	0,342	9,244	4	0,133	3,738	**51**	**8,500**	**0,275**	**8,871**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	0	0,000	0,000	0	0,000	0,000	1	0,034	1,114	1	0,031	1,003	1	0,034	0,924	2	0,067	1,869	**5**	**0,833**	**0,027**	**0,870**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	**0**	**0,000**	**0,000**	**0,000**
Scientific papers published in foreign peer-reviewed proceedings *(AECA)*	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	**0**	**0,000**	**0,000**	**0,000**
Scientific papers published in domestic peer-reviewed proceedings *(AEDA)*	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	**0**	**0,000**	**0,000**	**0,000**
Published papers (full text) from foreign scientific conferences *(AFA, AFC)*	0	0,000	0,000	1	0,032	1,111	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	**1**	**0,167**	**0,005**	**0,174**
Published papers (full text) from domestic scientific conferences *(AFB, AFD)*	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0	0	**0**	**0**	**0**	**0**

2.2. Measures of research outputs (citations, etc.)

2.2.1. Table with citations per annum (without self-citations)

Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) are listed separately

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	512	15,53	504	15,96	504	17,07	649	20,07	655	22,39	740	24,63	**3 564**	**594,00**	**19,19**
Citations in SCOPUS (1.2, 2.2) if not listed above	45	1,37	32	1,01	61	2,07	51	1,58	42	1,44	63	2,10	**294**	**49,00**	**1,58**
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	179	5,43	114	3,61	94	3,18	190	5,88	178	6,08	130	4,33	**885**	**147,50**	**4,77**
Other citations (not listed above) (3.1, 4.1)	11	0,33	7	0,22	7	0,24	5	0,15	29	0,99	13	0,43	**72**	**12,00**	**0,39**
Reviews (5,6)	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	**0**	**0,00**	**0,00**

2.2.2. List of 10 most-cited publications published any time with the address of the institute, with number of citations in the assessment period (2015 – 2020)

1) CEPLECHA, Zdeněk - BOROVIČKA, Jiří - ELFORD, William G. - REVELLE, Douglas O. - HAWKES, Robert L. - PORUBČAN, Vladimír - ŠIMEK, Miroslav. Meteor phenomena and bodies. In *Space Science Reviews*, 1998, vol. 84, p. 327-471. ISSN 0038-6308. **Citations: 208**
2) PRIBULLA, Theodor - RUCINSKI, Slavek M. Contact binaries with additional components. I. The extant data. In *The Astronomical Journal*, 2006, vol. 131, p. 2986-3007. (2005: 5.377 - IF, Q1 - JCR, 5.598 - SJR, Q1 - SJR, karentované - CCC). (2006 - Current Contents). ISSN 0004-6256. **Citations: 94**
3) BURROWS, Adam - HUBENY, Ivan - BUDAJ, Ján - HUBBARD, Wiliam. Possible solutions to the radius anomalies of transiting giant planets. In *The Astrophysical Journal*, 2007, vol. 661, p. 502-514. (2006: 6.119 - IF, Q1 - JCR, 4.603 - SJR, Q1 - SJR, karentované - CCC). (2007 - Current Contents). ISSN 0004-637X. **Citations: 73**
4) AUBÉ, Martin - ROBY, Johanne - KOCIFAJ, Miroslav. Evaluating potential spectral impacts of various artificial lights on melatonin suppression, photosynthesis, and star visibility. In *PLoS ONE*, 2013, vol. 8, no. 7, article no. E67798, p. 1-15. (2012: 3.730 - IF, Q1 - JCR, 1.982 - SJR, Q1 - SJR). (2013 - MEDLINE). ISSN 1932-6203. Available at: https://doi.org/10.1371/journal.pone.0067798. **Citations: 72**
5) ORTIZ, J. L. - SANTOS-SANZ, P. - SICARDY, Bruno - BENEDETTI-ROSSI, G. - BERARD, D. - MORALES, N. - DUFFARD, R. - BRAGA-RIBAS, F. - HOPP, U. - RIES, Christoph - NASCIMBENI, V. - MARZARI, F. - GRANATA, V. - PÁL, A. - KISS, C. - PRIBULLA, Theodor - KOMŽÍK, Richard - HORNOCH, Kamil - PRAVEC, Petr - BACCI, Paolo - MAESTRIPIERI, Martina - NERLI, L. - MAZZEI, L. - BACHINI, M. - MARTINELLI, F. - SUCCI, G. - CIABATTARI, F. - MIKUZ, H. - CARBOGNANI, A. - GAEHRKEN, B. - MOTTOLA, Stefano - HELLMICH, Stephan - ROMMEL, F. L. - FERNANDEZ-VALENZUELA, E. - CAMPO BAGATIN, A. - CIKOTA, S. - CIKOTA, A. - LECACHEUX, Jean - VIEIRA-MARTINS, R. - CAMARGO, J. I. B. - ASSAFIN, M. - COLAS, Francois - BEHREND, Raoul - DESMARS, J. - MEZA, E. - ALVAREZ-CANDAL, Alvaro - BEISKER, W. - GOMES-JUNIOR, A. R. - MORGADO, B. E. - ROQUES, F. - VACHIER, Frédéric - BERTHIER, J. - MUELLER, T. G. - MADIEDO, J. M. - UNSALAN, O. - SONBAS, E. - KARAMAN, N. - ERECE, O. - KOSEOGLU, D. T. - OZISIK, T. - KALKAN, S. - GUNEY, Y. - NIAEI, M. S. - SATIR, O. - YESILYAPRAK, C. - PUSKULLU, C. - KABAS, A. - DEMIRCAN, Osman - ALIKAKOS, J. - CHARMANDARIS, V. - LETO, G. - OHLERT, Johannes - CHRISTILLE, J. M. - SZAKÁTS, R. - TAKÁCSNÉ FARKAS, A. - VARGA-VEREBÉLYI, E. - MARTON, G. - MARCINIAK, Anna - BARTCZAK, P. - SANTANA-ROS, Toni - BUTKIEWICZ-BAK, M. - DUDZINSKI, G. - ALI-LAGOA, V. - GAZEAS, Kosmas - TZOUGANATOS, L. - PASCHALIS, N. - TSAMIS, V. - SÁNCHEZ-LAVEGA, A. - PÉREZ-HOYOS, S. - HUESO, R. - GUIRADO, J. C. - PERIS, V. - IGLESIAS-MARZOA, R. The size, shape, density and ring of the dwarf planet Haumea from a stellar occultation. In *Nature*, 2017, vol. 550, no. 7675, p. 219-223. (2016: 40.137 - IF, Q1 - JCR, 18.389 - SJR, Q1 - SJR, karentované - CCC). (2017 - Current Contents). ISSN 0028-0836. Available at: https://doi.org/10.1038/nature24051. **Citations: 64**
6) TEMMER, Manuela - RYBÁK, Ján - BENDÍK, Pavol - VERONIG, Astrid - VOGLER, Franz - OTRUBA, Wolfgang - PÖTZI, Werner - HANSLMEIER, Arnold. Hemispheric sunspot numbers Rn and Rs from 1945-2004: catalogue and N-S asymmetry analysis for solar cycles 18-23. In *Astronomy and Astrophysics*, 2006, vol. 447, p.735-743. (2005: 4.223 - IF, Q1 - JCR, 3.265 - SJR, Q1 - SJR, karentované - CCC). (2006 - Current Contents). ISSN 0004-6361. **Citations: 53**
7) BURROWS, Adam - BUDAJ, Ján - HUBENY, Ivan. Theoretical spectra and light curves of close-in extrasolar giant planets and comparison with data. In *The Astrophysical Journal*, 2008, vol. 678, p. 1436-1457. (2007: 6.405 - IF, Q1 - JCR, 3.399 - SJR, Q1 - SJR, karentované - CCC). (2008 - Current Contents). ISSN 0004-637X. Available at: https://doi.org/10.1086/533518. **Citations: 48**
8) BOTTICELLA, Maria-Teresa - PASTORELLO, Andrea - SMARTT, Stephen J. - MEIKLE, W. Peter S. - BENETTI, Stefano - KOTAK, Rubina - CAPPELLARO, Enriko - CROCKETT, R.Mark - MATTILA, Seppo - SERENO, Mauro - PATAT, Ferdinando - TSVETKOV, Dmitry Yu. - VAN LOON, Jacco Th. - ABRAHAM, Douglas - AGNOLETTO, Irene - ARBOUR, Ron - BENN, Chris - DI RICO, Gianluca - ELIAS-ROSA, Nancy - GORSHANOV, Dmitry L. - HARUTYUNYAN, Artak -

HUNTER, Deidre - LORENZI, Vania - KEENAN, Francis P. - MAGUIRE, Kate - MENDEZ, Jeffrey - MOBBERLEY, Martin - NAVASARDYAN, Hripsime - RIES, Christoph - STANISHEV, Vallery - TAUBENBERGER, Stefan - TRUNDLE, Carol - TURATTO, Massimo - VOLKOV, Igor. SN 2008S: an electron-capture SN from a super AGB progenitor. In *Monthly Notices of the Royal Astronomical Society*, 2009, vol. 398, p. 1041-1068. (2008: 5.185 - IF, Q1 - JCR, 3.600 - SJR, Q1 - SJR, karentované - CCC). (2009 - Current Contents, SCOPUS, NASA ADS). ISSN 0035-8711. **Citations: 46**

9) MEECH, Karen J. - SVOREŇ, Ján. Using cometary activity to trace the physical and chemical evolution of cometary nuclei. In *Comets II*. - Tucson : University of Arizona Press, 2005, p. 317-335. ISBN 0-8165-2450-5. **Citations: 46**
10) MEECH, Karen J. - PITTICHOVÁ, Jana - BAR-NUN, Akiva - NOTESCO, Gilano - LAUFER, Diana - HAINAUT, Olivier R. - LOWRY, Stephen C. - YEOMANS, Donald K. - PITTS, Mark. Activity of comets at large heliocentric distances pre-perihelion. In *Icarus*, 2009, vol. 201, p. 719-739. (2008: 3.268 - IF, Q2 - JCR, 2.584 - SJR, Q1 - SJR, karentované - CCC). (2009 - Current Contents, EBSCO, NASA ADS). ISSN 0019-1035. **Citations: 45**

2.2.3. List of 10 most-cited publications published any time with the address of the institute, with number of citations obtained until 2020

1) CEPLECHA, Zdeněk - BOROVIČKA, Jiří - ELFORD, William G. - REVELLE, Douglas O. - HAWKES, Robert L. - PORUBČAN, Vladimír - ŠIMEK, Miroslav. Meteor phenomena and bodies. In *Space Science Reviews*, 1998, vol. 84, p. 327-471. ISSN 0038-6308. **Citations: 532**
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3) PRIBULLA, Theodor - RUCINSKI, Slavek M. Contact binaries with additional components. The extant data. In *The Astronomical Journal*, 2006, vol. 131, p. 2986-3007. (2005: 5.377 – IF, Q1 - JCR, 5.598 - SJR, Q1 - SJR, Current Contents - CCC). (2006 - Current Contents). ISSN 0004-6256. **Citations: 218**
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5) BURROWS, Adam - HUBENY, Ivan - BUDAJ, Ján - KNUTSON, Heather A. – CHARBONNEAU, David. Theoretical spectral models of the planet HD 209458b with a thermal inversion and water emission bands. In *The Astrophysical Journal*, 2007, vol. 668, p. L171-L174. (2006: 6.119 - IF, Q1 - JCR, 4.603 - SJR, Q1 - SJR, Current Contents - CCC). (2007 - Current Contents). ISSN 0004-637X. **Citations: 131**
6) TEMMER, Manuela - RYBÁK, Ján - BENDÍK, Pavol - VERONIG, Astrid - VOGLER, Franz - OTRUBA, Wolfgang - PÖTZI, Werner - HANSLMEIER, Arnold. Hemispheric sunspot numbers Rn and Rs from 1945-2004: catalogue and N-S asymmetry analysis for solar cycles 18-23. In *Astronomy and Astrophysics*, 2006, vol. 447, p.735-743. (2005: 4.223 - IF, Q1 - JCR, 3.265 - SJR, Q1 - SJR, Current Contents - CCC). (2006 - Current Contents). ISSN 0004-6361. **Citations: 116**
7) TEMMER, Manuela - VERONIG, Astrid - VRŠNAK, Bojan - RYBÁK, Ján - GÖMÖRY, Peter - STOISER, Sigrid - MARIČIČ, Darije. Acceleration in fast halo CMEs and synchronized flare HXR bursts. In *The Astrophysical Journal*, 2008, vol. 673, p. L95-L98. (2007: 6.405 - IF, Q1 - JCR, 3.399 - SJR, Q1 - SJR, Current Contents - CCC). (2008 – Current Contents). ISSN 0004-637X. **Citations: 104**
8) PRIBULLA, Theodor - KREINER, Jerzy - TREMKO, Jozef. Catalogue of the field contact binary stars. In *Contributions of the Astronomical Observatory Skalnaté Pleso*, 2003, vol. 33, no. 1, p. 38-70. (2003 - Current Contents, NASA ADS). ISSN 1335-1842. **Citations: 97**
9) BOTTICELLA, Maria-Teresa - PASTORELLO, Andrea - SMARTT, Stephen J. - MEIKLE, W. Peter S. - BENETTI, Stefano - KOTAK, Rubina - CAPPELLARO, Enriko – CROCKETT, R.Mark - MATTILA, Seppo - SERENO, Mauro - PATAT,

Ferdinando – TSVETKOV, Dmitry Yu. - VAN LOON, Jacco Th. - ABRAHAM, Douglas – AGNOLETTO, Irene - ARBOUR, Ron - BENN, Chris - DI RICO, Gianluca - ELIAS-ROSA, Nancy - GORSHANOV, Dmitry L. - HARUTYUNYAN, Artak - HUNTER, Deidre – LORENZI, Vania - KEENAN, Francis P. - MAGUIRE, Kate - MENDEZ, Jeffrey – MOBBERLEY, Martin - NAVASARDYAN, Hripsime - RIES, Christoph - STANISHEV, Vallery - TAUBENBERGER, Stefan - TRUNDLE, Carol - TURATTO, Massimo – VOLKOV, Igor. SN 2008S: an electron-capture SN from a super AGB progenitor. In *Monthly Notices of the Royal Astronomical Society*, 2009, vol. 398, p. 1041-1068. (2008: 5.185 - IF, Q1 - JCR, 3.600 - SJR, Q1 - SJR, Current Contents - CCC). (2009 - Current Contents, SCOPUS, NASA ADS). ISSN 0035-8711. **Citations: 95**

10) MEECH, Karen J. - SVOREŇ, Ján. Using cometary activity to trace the physical and chemical evolution of cometary nuclei. In *Comets II*. - Tucson : University of Arizona Press, 2005, p. 317-335. ISBN 0-8165-2450-5. **Citations: 93**

2.2.4. List of 10 most-cited publications published during the evaluation period (2016-2021) with the address of the Institute, with number of citations obtained until 2021

1) ORTIZ, J. L. - SANTOS-SANZ, P. - SICARDY, Bruno - BENEDETTI-ROSSI, G. - BERARD, D. - MORALES, N. - DUFFARD, R. - BRAGA-RIBAS, F. - HOPP, U. - RIES, Christoph - NASCIMBENI, V. - MARZARI, F. - GRANATA, V. - PÁL, A. - KISS, C. - PRIBULLA, Theodor - KOMŽÍK, Richard - HORNOCH, Kamil - PRAVEC, Petr - BACCI, Paolo - MAESTRIPIERI, Martina - NERLI, L. - MAZZEI, L. - BACHINI, M. - MARTINELLI, F. - SUCCI, G. - CIABATTARI, F. - MIKUZ, H. - CARBOGNANI, A. - GAEHRKEN, B. - MOTTOLA, Stefano - HELLMICH, Stephan - ROMMEL, F. L. - FERNANDEZ-VALENZUELA, E. - CAMPO BAGATIN, A. - CIKOTA, S. - CIKOTA, A. - LECACHEUX, Jean - VIEIRA-MARTINS, R. - CAMARGO, J. I. B. - ASSAFIN, M. - COLAS, Francois - BEHREND, Raoul - DESMARS, J. - MEZA, E. - ALVAREZ-CANDAL, Alvaro - BEISKER, W. - GOMES-JUNIOR, A. R. - MORGADO, B. E. - ROQUES, F. - VACHIER, Frédéric - BERTHIER, J. - MUELLER, T. G. - MADIEDO, J. M. - UNSALAN, O. - SONBAS, E. - KARAMAN, N. - ERECE, O. - KOSEOGLU, D. T. - OZISIK, T. - KALKAN, S. - GUNEY, Y. - NIAEI, M. S. - SATIR, O. - YESILYAPRAK, C. - PUSKULLU, C. - KABAS, A. - DEMIRCAN, Osman - ALIKAKOS, J. - CHARMANDARIS, V. - LETO, G. - OHLERT, Johannes - CHRISTILLE, J. M. - SZAKÁTS, R. - TAKÁCSNÉ FARKAS, A. - VARGA-VEREBÉLYI, E. - MARTON, G. - MARCINIAK, Anna - BARTCZAK, P. - SANTANA-ROS, Toni - BUTKIEWICZ-BAK, M. - DUDZINSKI, G. - ALI-LAGOA, V. - GAZEAS, Kosmas - TZOUGANATOS, L. - PASCHALIS, N. - TSAMIS, V. - SÁNCHEZ-LAVEGA, A. - PÉREZ-HOYOS, S. - HUESO, R. - GUIRADO, J. C. - PERIS, V. - IGLESIAS-MARZOA, R. The size, shape, density and ring of the dwarf planet Haumea from a stellar occultation. In *Nature*, 2017, vol. 550, no. 7675, p. 219-223. (2016: 40.137 - IF, Q1 - JCR, 18.389 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0028-0836. https://doi.org/10.1038/nature24051. **Citations: 75**
2) SHANKMAN, Cory - KAVELAARS, J.J. - BANNISTER, Michele T. - GLADMAN, Brett J. - LAWLER, Samantha - CHEN, Ying-Tung - JAKUBÍK, Marián - KAIB, Nathan - ALEXANDERSEN, Mike - GWYN, Stephen D. J. - PETIT, Jean-Marc - VOLK, Kathryn. OSSOS. VI. Striking biases in the detection of large semimajor axis trans-Neptunian objects. In *The Astronomical Journal*, 2017, vol. 154, article no. 50, p. 1-8. (2016: 2.609 - IF, Q2 - JCR, 2.511 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6256. Available at: https://doi.org/10.3847/1538-3881/aa7aed. **Citations 38**
3) PRAVEC, Petr - SCHEIRICH, Petr - KUŠNIRÁK, Peter - HORNOCH, Kamil - GALÁD, Adrián - NAIDU, S.P. - PRAY, Donald P. - VILÁGI, Jozef - GAJDOŠ, Štefan - KORNOŠ, Leoš - KRUGLY, Yurij N. - COONEY, Walter R. Jr. - GROSS, John - TERRELL, Dirk - GAFTONYUK, Ninel - POLLOCK, Joseph - HUSÁRIK, Marek - CHIORNY, Vasilij - STEPHENS, Robert D. - DURKEE, Russ - REDDY, Vishnu - DYVIG, Ron - VRAŠTIL, Jan - ŽIŽKA, J. - MOTTOLA, Stefano - HELLMICH, Stephan - OEY, Julian - BENISHEK, Vladimir - KRYSZCZYŃSKA, Agnieszka - HIGGINS, David - RIES, Judit G. - MARCHIS, Franck - BAEK, M. - MACOMBER, Brent - INASARIDZE, Raguli - KVARATSKHELIA, O. - AYVASIAN, Vova - RUMYANTSEV, V. - MASI, Gianluca - COLAS, Francois - LECACHEUX,

Jean - MONTAIGUT, R. - LEROY, Arnaud - BROWN, Peter - KRZEMINSKI, Zbigniew - MOLOTOV, Igor - REICHART, Daniel - HAISLIP, Josh - LA CLUYZE, Aaron. Binary asteroid population. 3. Secondary rotations and elongations. In *Icarus*, 2016, vol. 267, p. 267-295. (2015: 3.383 - IF, Q2 - JCR, 2.314 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0019-1035. Available at: https://doi.org/10.1016/j.icarus.2015.12.019. **Citations: 29**

4) JOPEK, Tadeusz J. - KAŇUCHOVÁ, Zuzana. IAU Meteor Data Center - the shower database: A status report. In *Planetary and Space Science*, 2017, vol. 143, p. 3-6. (2016: 1.892 - IF, Q3 – JCR, 1.207 - SJR, Q2 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0032-0633. Available at: https://doi.org/10.1016/j.pss.2016.11.003. **Citations: 29**
5) KURIDZE, David - MATHIOUDAKIS, Mihalis - MORGAN, Huw - OLIVER, Ramon - KLEINT, L. - ZAQARASHVILI, T. V. - REID, A. - KOZA, Július - LOFDAHL, M. G. - HILLBERG, T. - KUKHIANIDZE, V. - HANSLMEIER, Arnold. Mapping the magnetic field of flare coronal loops. In *The Astrophysical Journal*, 2019, vol. 874, no. 2, article no. 126, p. 1-12. (2018: 5.580 - IF, Q1 - JCR, 2.741 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-637X. Available at: https://doi.org/10.3847/1538-4357/ab08e9. **Citations: 27**
6) BANNISTER, Michele T. - GLADMAN, Brett J. - KAVELAARS, J.J. - PETIT, Jean-Marc - VOLK, Kathryn - CHEN, Ying-Tung - ALEXANDERSEN, Mike - GWYN, Stephen D. J. - SCHWAMB, Megan E. - ASHTON, Edward - BENECCHI, Susan D. - CABRAL, Nahuel - DAWSON, Rebekah I. – DELSANTI, Audrey - FRASER, Wesley C. - GRANVIK, Mikael - GREENSTREET, Sarah – GUILBERT-LEPOUTRE, Aurelie - IP, Wing-Huen - JAKUBÍK, Marián - JONES, Lynne R. - KAIB, Nathan - LACERDA, Pedro - VAN LAERHOVEN, Christa - LAWLER, Samantha - LEHNER, Matthew J. - LIN, Hsing Wen - LYKAWKA, Patryk Sofia - MARSSET, Michael - MURRAY-CLAY, Ruth - PIKE, Rosemary E. - ROUSSELOT, Philippe - SHANKMAN, Cory - THIROUIN, Audrey – VERNAZZA, Pierre - WANG, Shiang-Yu. OSSOS. VII. 800+ Trans-Neptunian objects - the complete data release. In *The Astrophysical Journal Supplement Series*, 2018, vol. 236, no. 1, article no. 18, p. 1-19. (2017: 8.561 - IF, Q1 - JCR, 4.660 - SJR, Q1 - SJR, Current Contents – CCC). (2018 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0067-0049. Available at: https://doi.org/10.3847/1538-4365/aab77a. **Citations: 26**
7) BANNISTER, Michele T. - KAVELAARS, J.J. - PETIT, Jean-Marc - GLADMAN, Brett J. - GWYN, Stephen D. J. - CHEN, Ying-Tung - VOLK, Kathryn - ALEXANDERSEN, Mike - BENECCHI, Susan D. - DELSANTI, Audrey - FRASER, Wesley C. - GRANVIK, Mikael - GRUNDY, Will M. - GUILBERT-LEPOUTRE, Aurelie - HESTROFFER, Daniel - IP, Wing-Huen - JAKUBÍK, Marián - JONES, R. Lynne - KAIB, Nathan - KAVELAARS, Catherine F. - LACERDA, Pedro - LAWLER, Samantha - LEHNER, Matthew J. - LIN, Hsing Wen - LISTER, Tim - LYKAWKA, Patryk Sofia - MONTY, Stephanie - MARSSET, Michael - MURRAY-CLAY, Ruth - NOLL, Keith S. - PARKER, Alex - PIKE, Rosemary E. - ROUSSELOT, Philippe - RUSK, David - SCHWAMB, Megan E. - SHANKMAN, Cory - SICARDY, Bruno - VERNAZZA, Pierre - WANG, Shiang-Yu. The outer solar system origins survey. I. Design and first-quarter discoveries. In *The Astronomical Journal*, 2016, vol. 152, no. 3, article no. 70, p. 1-25. (2015: 4.617 - IF, Q1 - JCR, 3.051 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6256. Available at: https://doi.org/10.3847/0004-6256/152/3/70. **Citations: 25**
8) SPURNÝ, Pavel - BOROVIČKA, Jiří - MUCKE, H. - SVOREŇ, Ján. Discovery of a new branch of the Taurid meteoroid stream as a real source of potentially hazardous bodies. In *Astronomy and Astrophysics*, 2017, vol. 605, article no. A68, p. 1-25. (2016: 5.014 - IF, Q1 - JCR, 2.234 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201730787. **Citations: 25**
9) KAŇUCHOVÁ, Zuzana - URSO, Riccardo Giovanni - BARATTA, Giuseppe Antonio - BRUCATO, John R. - PALUMBO, Maria Elisabetta - STRAZZULLA, Giovanni. Synthesis of formamide and isocyanic acid after ion irradiation of frozen gas mixtures. In *Astronomy and Astrophysics*, 2016, vol. 585, article no. A155, p. 1-8. (2015: 5.185 - IF, Q1 - JCR, 2.545 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201527138. **Citations: 24**

10) NESLUŠAN, Luboš - BUDAJ, Ján. Mysterious eclipses in the light curve of KIC8462852: a possible explanation. In *Astronomy and Astrophysics*, 2017, vol. 600, article no. A86, p. 1-20. (2016: 5.014 - IF, Q1 - JCR, 2.234 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS, SCOPUS, NASA ADS). ISSN 0004-6361. Available at: https://doi.org/10.1051/0004-6361/201629344. **Citations: 23**

2.2.5. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations in the assessment period (2015– 2020). The cited papers must bear the address of the institute

1) RNDr. Theodor Pribulla, CSc.: 725 citations
2) RNDr. Ján Budaj, CSc.: 435 citations
3) prof. RNDr. Vladimír Porubčan, DrSc.: 416 citations

2.2.6. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2020. The cited papers must bear the address of the Institute

1) RNDr. Theodor Pribulla, CSc.: 1859 citations
2) RNDr. Ján Budaj, CSc.: 1130 citations
3) RNDr. Drahomír Chochol, DrSc.: 1108 citations

2.2.7. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2021 of their papers published during the evaluation period (2016– 2021). The cited papers must bear the address of the Institute

1) Mgr. Marián Jakubík, PhD.: 133 citations
2) RNDr. Theodor Pribulla, CSc.: 129 citations
3) Sergey Shugarov, CSc.: 118 citations

2.3. Research status of the institute in international and national context

- **International/European position of the institute**

2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items for institute with less than 50 average FTE researchers per year, max. 20 for institutes with 50 – 100 average FTE researchers per year and so on

1) AI SAS is a member of the EST project (European Solar Telescope - An advanced telescope for observing the Sun and its magnetic activity), which was in 2016 officially introduced as one of six new infrastructures in ESFRI ROAD MAP (European Strategy Forum on Research Infrastructures) in section "Physical Sciences and Engineering" (see Annex 1). Institutes from 15 European countries are involved in this ESFRI project.
2) In the evaluation period, AI SAS has been a partner in 3 top-level projects of FP7/H2020 frameworks (H2020-INFRAIA-2018-2020 SOLARNET: 824135, H2020-INFRADEV-2016-2017 PRE-EST: 739500, FP7-INFRA-312495) and in one COST project (COST TD 1308). Besides that, AI SAS coordinated/participated additional 13 international and multilateral projects. It represents wide acceptance of AI SAS in the European Research Area.
3) AI SAS participates in 2 Erasmus+ projects (No. 2020-1-CZ01-KA203-078200, No. 2017-1-CZ01-KA203-035562) – main goal of these projects was/is the development of new leaders in astronomical research as achieved by international mobilities and educate our early career researchers in topics of astronomy which are active areas of research at all partner institutes.
4) AI SAS is a founding member of the "Consortium EAST – European Association for Solar Telescopes". “The goal of the EAST is to ensure access of European solar astronomers to world-class high-resolution ground-based observing facilities”. The membership is based on high credibility of AI SAS in the European solar research and guarantees to AI SAS (as a member) an access to the top-level telescopes and

technique used in solar research. At present, EAST brings together 26 institutions from 18 European countries (for details see: https://www.est-east.eu/east-members)

5) AI SAS is the institution with very high credibility in the field of meteor research and cometary-asteroidal research. AI SAS maintains the IAU Meteor Data Center, which is a central depository and database summarizing all precise meteor orbits and meteor showers.
6) AI SAS organized/co-organized 5 important international conferences during the evaluation period.
7) AI SAS has been involved in the Outer Solar System Origins Survey (OSSOS) - the highest-priority Large Program on the 3.6m Canada-France-Hawaii Telescope (Mauna Kea). OSSOS is an international collaboration, involving more than forty scientists at institutes in eight countries. OSSOS has yielded more than 1000 TNOs inhabiting the outer Solar System, with highly precise orbits, and dynamical classification.
8) AI SAS participated in the preparation of the "Critical Science Plan for the Daniel K. Inouye Solar Telescope" (DKiST – the 4-metre solar telescope operated in the USA).
9) AI SAS has coordinated a multi-site observing campaign Dwarf aimed at detection of circumbinary planets around eclipsing binary stars. AI SAS participated also in a multi-site observing campaign YETI (Young Exoplanet Transit Initiative) focused on a detection of transiting exoplanets in young open clusters. The campaign was coordinated by the Astrophysikalisches Institut FSU Jena, Germany.
10) The 1.3-m telescope at the Skalnate Pleso Observatory is involved in the Europlanet Telescope Network project. Within this project, AI SAS acts as an coordinator of the science advisory panel for comets.

2.3.2. List of international conferences (co)organised by the institute

1) Radiative Transfer in Solar and Stellar Atmospheres, Astronomical Institute, Slovak Academy of Sciences, Tatranská Lomnica, Slovakia, May 29 - June 2, 2017
2) Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24 - 28, 2018
3) Physics of comets after the Rosetta mission: Unresolved problems, Stará Lesná, Slovakia, September 5 - 7, 2018
4) Universe of binaries, binaries in the Universe, Telč, Czech Republic, September 7 - 11, 2019
5) Meteoroids 2019, Bratislava, Slovakia, June 17-21, 2019

2.3.3. List of edited proceedings from international scientific conferences

1) Proceedings of the conference "14th INTEGRAL/BART Workshop", Karlovy Vary (Carlsbad), Czech Republic, April 03-07, 2017 published in Contributions of the Astronomical Observatory Skalnate Pleso, Volume 47, Number 2, 2017
2) Proceedings of the conference "Stars with a stable magnetic field: from pre-main sequence to compact remnants", Brno, Czech Republic, August 28-September 01, 2017 published in Contributions of the Astronomical Observatory Skalnate Pleso, Volume 48, Number 1, 2018
3) Proceedings of the conference "10th International Workshop on Astronomical X-Ray Optics", Prague, Czech Republic, December 4-7, 2017 published in Contributions of the Astronomical Observatory Skalnate Pleso, Volume 48, Number 3, 2018
4) Proceedings of the workshop "Observing techniques, instrumentation and science for metre-class telescopes II", Tatranská Lomnica, Slovakia, September 24-28, 2018 published in Contributions of the Astronomical Observatory Skalnate Pleso, Volume 49, Number 2, 2019
5) Proceedings of the conference "Spectral line shapes in astrophysics and related topics" 12th Serbian Conference on spectral line shapes in astrophysics, Vrdnik, Serbia, June 3-7, 2019 published in Contributions of the Astronomical Observatory Skalnate Pleso, Volume 50, Number 1, 2020
6) Proceedings of the conference "Universe of binaries, binaries in the Universe", September 7 – 11, 2019, Telč, Czech Republic published in Contributions of the Astronomical Observatory Skalnate Pleso, Volume 50, Number 2, 2020
7) Proceedings of the conference "VII Bredikhin Conference", Zavolzhsk, Russia, May 24 - 28, 2021 published in Contributions of the Astronomical Observatory Skalnate Pleso, Volume 51, Number 3, 2021

2.3.4. List of journals edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

Journal published at AI SAS
name: Contributions of the Astronomical Observatory Skalnate Pleso (CAOSP)
https://www.ta3.sk/caosp/caosp.php
indexed by: WOS: Web of Science (since 2007), SCOPUS (since 2008),
NASA ADS, Index Copernicus International
Impact factor and metrices:
WoS impact factor: 2016 – 0.336, 2017 – 0.733, 2018 – 0.833, 2019 – 0.636, 2020 – 0.316
Scimago SJR quartile: 2016 – Q4, 2017 – Q3, 2018 – Q3, 2019 – Q3, 2020 – Q4, 2021 – Q4

- **National position of the institute**

2.3.5. List of selected activities of national importance

AI SAS is the leading scientific organisation in Slovakia in astronomy and astrophysics. Scientists of AI SAS are members of important national bodies including those at the Slovak Academy of Sciences. They act in national committees of international unions and in Slovak Astronomical Society. Currently, the institute is principal investigator of Centre of Excellence - Centre of space research: “Influences of the space weather”.

1) AI SAS is a member of the EST project, which has been involved in the first Slovak Roadmap for Research Infrastructures – SK VI Roadmap 2020 – 2030, which is a key document of Slovak Republic for research infrastructures published in 2021,
2) AI SAS scientists refereed overall 41 national grants and projects during the evaluated period
3) AI SAS scientists prepared 14 articles for „The Encyclopaedia Beliana“, which is a general Slovak encyclopaedia and it is comprised of articles about science, technology, society and the humanities with a focus on articles related to Slovak realities
4) AI SAS is a key institution in Slovakia to provide correct information with respect to hoaxes and fake news in the astrophysical field and thus helps to limit false rumours which often have very negative impact on the society and causes even economic damages, in general this contributes to the education of people,
5) AI SAS intensively cooperates with massmedial and printed media, systematic work in this field has led to high professionalism and effectiveness in popularization,
6) AI SAS provides a public service on its website entitled "Do you have a question for an expert?". The website visitor can use a simple form to contact experts (AI SAS staff) in 20 different thematic areas related to astronomy and astrophysics and hence obtain a relevant answer to potential questions.
7) AI SAS was awarded the silver medal for long-lasting collaboration with the Pavol Jozef Safarik University in Kosice which proves extensive pedagogical activities at the institute,
8) six different Slovak organisations provided individual awards to the AI SAS researchers,
9) scientists of AI SAS are members of the Slovak Astronomical Society - SAS, and regularly act as members of the Presidium of Main Committee of SAS; they are also members of the Slovak National Committee of IAU,
10) An AI SAS employee acts as a member of the SAS Presidency.

2.3.6. List of journals (published only in the Slovak language) edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

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- **Position of individual researchers in the international context**

2.3.7. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter

1) Skopal, A.: The B[e] phenomenon in symbiotic binaries. The B[e] Phenomenon: Forty Years of Studies. Prague, Czech Republic, 27.06-01.07.2016.
2) Skopal, A.: On the mass transfer and accretion in symbiotic binaries. Accretion processes in symbiotic stars and related objects - first Chile-Korea-Gemini workshop on stellar astrophysics. La Serena, Chile, 04.-07.12.2016.
3) Kaňuchová Z.: Laboratory simulations of space weathering effects. Some applications. 18th Serbian Astronomical Conference, Beograd, Serbia, 17.-21.10.2017
4) Kučera, A.: Sun - New picture from space research. Next Generation Space Policy: Space Strategy for Europe, Bratislava, Slovakia, 07.-08.09.2017.
5) Saniga, M.: Polar spaces and generalized polygons shaping quantum information. 55th Summer School on Algebra and Ordered Sets, Nový Smokovec, Slovakia, 03.-08.09.2017.
6) Skopal, A.: Multiwavelength models SED of the classical nova V339 Del (Nova Del 2013) along its age. The Golden Age of Cataclysmic Variables and Related Objects – IV. Palermo, Italy, 11.-16.09.2017
7) Gömöry P.: European solar telescope - EST. 24. National Solar Physics Meeting, Kežmarok, Slovakia, 21.-25.05.2018.
8) Kučera, A.: Slnko – nový pohľad z kozmu. 24. National Solar Physics Meeting, Kežmarok, Slovakia, 21.-25.05.2018.
9) Hajduková, M.: Interstellar meteors. Meteoroids 2019, Bratislava, Slovakia, 17.-21.06.2019.
10) Chochol, D.: Classical nova outburst of the dwarf nova V392 Per, International Workshop: The Golden Age of Cataclysmic Variables and Related Objects – V, Palermo, Italy, 01.-07.09.2019.
11) Pribulla, T.: Hands on session - spectroscopy. Observational Astrophysics: from Proposals to Publication, Astronomical Institute Slovak Academy of Sciences, Tatranská Lomnica, 17.-27.06.2019.
12) Saniga, M.: Doily – a gem of the quantum universe. The 9th Slovenian International Conference on Graph Theory, Bled, Slovenia, 23.-29.06.2019.
13) Hajduková, M.: Meteor observations of interstellar particles - review. The 2nd DIMS Workshop for Dark Matter and Interstellar Meteoroid Study, online conference, 05.12.2020.
14) Kučera, A.: Solar activity and climate change. 25. National Solar Physics Meeting, online conference, 20.-22.10.2020.
15) Kučera, A.: High resolution observation of the solar photosphere. SOLARNET Summer School - High Resolution Solar Physics, University of Graz, online conference, 30.08.-03.09.2021.
16) Ivanova O.: How did the Rosetta space mission change our idea of comets? The International conference: VII-th Bredikhin conference, Zovolzhsk, Russia, 24.-28.05.2021.
17) Saniga, M.: Taxonomy of Three-Qubit Doilies. The 8-th European Congress of Mathematics, Portoroz, Slovenia, online conference, 20.-26.06.2021.

2.3.8. List of researchers who served as members of the organising and/or programme committees

<u>Programme committees (SOC):</u>

1) Z. Kaňuchová: SOC member, COST TD-1308 Action: From star and planet formation to early life, Vilnius, Lithuania, April 25-28, 2016.
2) Z. Kaňuchová: SOC member, COST TD-1308 Action: Evolution of Chemical Complexity: From simple interstellar molecules to terrestrial biopolymers, Liblice, Czech Republic, September 13-15, 2016
3) A. Kučera: SOC member, XIV-th Hvar Astrophysical Colloquium: Solar and Solar-terrestrial physics – Now and in the Future, Hvar, Croatia, September 26-30, 2016
4) M. Saniga: SOC member, Symmetry Festival 2016, Wien, Austria, August 18-22, 2016
5) M. Hajduková: SOC member, The International Conference "VI Bredikhin Conference", Zavolzhsk, Ivanovo region, Russia, September 4-8, 2017
6) Z. Kaňuchová: SOC member, COST TD-1308 Action: Geoscience for understanding habitability in the Solar System and beyond, Furnas, Portugal, September 25-29, 2017

7) A. Kučera: SOC member, European Solar Telescope – EST Meeting, Bairisch Kölldorf, Austria, October 9-11, 2017
8) T. Pribulla: SOC member, EWASS - Special session 2: Cool Science on Hot Subjects - Demonstrating the Strengths and Needs of National 1-2m Class Telescopes, Prague, Czech Republic, June 27, 2017
9) J. Budaj: SOC member, Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24-28, 2018
10) O. Ivanova: SOC chair, Physics of comets after the Rosetta mission: Unresolved problems, Stará Lesná, Slovakia, September 25-28, 2018
11) Z. Kaňuchová: SOC member, COST Action TD-1308: Life on Earth and beyond: emergence, survivability and impact on the environment, Bertinoro, Italy, March 19-24, 2018
12) L. Neslušan: SOC member, Physics of comets after the Rosetta mission: Unresolved problems, Stará Lesná, Slovakia, September 25-28, 2018
13) J. Svoreň: SOC member, Physics of comets after the Rosetta mission: Unresolved problems, Stará Lesná, Slovakia, September 25-28, 2018
14) T. Pribulla: SOC member, Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24-28, 2018
15) A. Skopal: SOC member, Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24-28, 2018
16) J. Budaj: SOC member, Observational Astrophysics: from proposals to publication, Tatranská Lomnica, Slovakia, June 17-27, 2019
17) T. Pribulla: SOC member, Observational Astrophysics: from proposals to publication, Tatranská Lomnica, Slovakia, June 17-27, 2019
18) T. Pribulla: SOC member, Universe of Binaries, Binaries in the Universe, Telč, Czech Republic, September 7 – 11, 2019
19) L. Neslušan: SOC member, Meteoroids 2019, Bratislava, Slovakia, June 17-21, 2019
20) P. Gömöry: SOC member, 24. National Solar Physics Meeting, Kežmarok, Slovensko, May 21-25, 2018
21) P. Gömöry: SOC member, XVIIth Hvar Astrophysical Colloquium: The Sun and Heliosphere, online meeting, September 20-24, 2021

Organizing committees (LOC):

1) Z. Kaňuchová: LOC chair, Physics of comets after the Rosetta mission: Unresolved problems, Stará Lesná, Slovakia, September 25-28, 2018
2) Ľ. Hambálek: LOC member, Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24-28, 2018
3) M. Husárik: LOC member, Physics of comets after the Rosetta mission: Unresolved problems, Stará Lesná, Slovakia, September 25-28, 2018
4) M. Jakubík: LOC member, Physics of comets after the Rosetta mission: Unresolved problems, Stará Lesná, Slovakia, September 25-28, 2018
5) R. Komžík: LOC member, Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24-28, 2018
6) E. Kundra: LOC member, Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24-28, 2018
7) M. Sekeráš: LOC member, Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24-28, 2018
8) N. Shagatova: LOC member, Observing techniques, instrumentation and science for metre-class telescopes II, Tatranská Lomnica, Slovakia, September 24-28, 2018
9) M. Benko: LOC member, Observational Astrophysics: from proposals to publication, Tatranská Lomnica, Slovakia, June 17-27, 2019
10) M. Hajduková: LOC member, Meteoroids 2019, Bratislava, Slovakia, June 17-21, 2019
11) Ľ. Hambálek: LOC member, Observational Astrophysics: from proposals to publication, Tatranská Lomnica, Slovakia, June 17-27, 2019
12) R. Komžík: LOC member, Observational Astrophysics: from proposals to publication, Tatranská Lomnica, Slovakia, June 17-27, 2019
13) E. Kundra: LOC member, Observational Astrophysics: from proposals to publication, Tatranská Lomnica, Slovakia, June 17-27, 2019
14) N. Shagatova: LOC member, Observational Astrophysics: from proposals to publication, Tatranská Lomnica, Slovakia, June 17-27, 2019
15) R. Komžík: LOC member, Universe of Binaries, Binaries in the Universe, Telč, Czech Republic, September 7-11, 2019

2.3.9. List of researchers who received an international scientific award

T. Pribulla, 2019: Outstanding Reviewer Award, given by: IOP Publishing

- **Position of individual researchers in the national context**

2.3.10. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter

1) Skopal, A.: Symbiotic stars – the widest interacting binaries. KOLOS 2017: International meeting on variable stars research, Astronomical Observatory at the Kolonické sedlo, Slovakia, 30.11.-02.12.2017
2) Hambálek, Ľ.: V392 Per – A dwarf nova turned regular nova. Bezovec 2020, online conference, Slovakia, 01.-02.10.2020
3) Husárik, M.: Research of asteroids and comets at the Astronomical Institute of the Slovak Academy of Sciences. Bezovec 2020, online conference, Slovakia, 01.-02.10.2020.

2.3.11. List of researchers who served as members of organising and programme committees of national conferences

Programme committees (SOC):

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Organizing committees (LOC):

1) Ľ. Hambálek: LOC member, 49th conference about successes of stellar astronomy, Bezovec, Slovakia, 2017
2) Ľ. Hambálek: LOC member, 50th conference about successes of stellar astronomy, Bezovec, Slovakia, 2018
3) Ľ. Hambálek: LOC member, 51st conference about successes of stellar astronomy, Bezovec, Slovakia, 2019
4) Ľ. Hambálek: LOC member, Bezovec 2020, online, 2020
5) Ľ. Hambálek: LOC member, Bezovec 2021, Bezovec, Slovakia, 2021

2.3.12. List of researchers who received a national scientific award

1) V. Rušin, 2016: Medal of Slovak physical society at the Slovak Academy of Sciences, given by: Slovak physical society at the Slovak Academy of Sciences
2) V. Rušin, 2016: Prize for scientific and professional literature for 2015 in the category of natural and technical sciences, given by: Literárny fond, Section for scientific literature and computer programs
3) J. Svoreň, 2016: Science and Technology Award 2016 in the category: Science Popularizer, given by: Minister of Education, Science, Research and Sports of the Slovak Republic
4) J. Svoreň, 2018: Gold medal for contribution to the development of the study of astronomy and astrophysics, given by: Faculty of Science, Pavol Jozef Šafárik University in Košice
5) S.J. González Manrique, 2019: Award for top publication, given by: Slovak Academy of Sciences
6) V. Rušin, 2020: Professor Štefan Kassay Foundation for the Support of Science and Education (Gold Medal), given by: President of the Foundation - Prof. Ing. Š. Kassay, DrSc., Dr. h. c. mult.

2.4. Research grants and other funding resources

(List type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator "C", work package leader "W", investigator "I". Add information on the projects which are interdisciplinary, and also on the joint projects with several participating SAS institutes)

- **International projects**

2.4.1. List of major projects of Framework Programmes of the EU (which pilar), NATO, COST, etc.

H2020 / FP7 projects:

1) H2020 project, Integrating High Resolution Solar Physics, No. H2020-INFRAIA-2018-2020 SOLARNET: 824135, 01.01.2019-31.12.2022, total funding: 9 995 736 EUR, funding for institute: 86 375 EUR, P. Gömöry - Coordinator for Slovakia
2) H2020 project, Preparatory Phase for the European Solar Telescope, No. H2020-INFRADEV-2016-2017 PRE-EST: 739500, 01.04.2017-30.09.2022, total funding: 3 998 750 EUR, funding for institute: 18 750 EUR, P. Gömöry - Coordinator for Slovakia
3) FP7 project, SOLARNET-High-Resolution Solar Physics Network, No. FP7-INFRA-312495, 01.04.2013-31.03.2017, total funding: 6 000 000 EUR, funding for institute: 59 856 EUR, A. Kučera – Coordinator for Slovakia

Add information on your activities in international networks

We provide short information about the most important activities of AI SAS in the international projects listed above:

1) SOLARNET 824135: The main activities within the project are: to participate in the preparation, implementation and evaluation of coordinated observations of the Sun using the largest European solar telescopes; to develop a software for automated reduction of measurements obtained by instruments at the Lomnicky Stit Observatory; to organize summer-school “Solar corona – complex research from ground and space” in Tatranska Lomnica; to participate in the development of the Virtual Solar Observatory.
2) PRE-EST 739500: The European Solar Telescope (EST) will be a revolutionary Research Infrastructure that will play a major role in answering key questions in modern Solar Physics. During the preparatory phase, our main goal is to perform following steps on the national level: to explore adequate legal structures and related governance schemes, so Slovak grant agencies can find the way to accommodate their standards in order to formally join the project; to explore funding schemes and funding sources for EST; to enhance and intensify outreach activities and strategic links with the user communities of EST; to prepare detailed technical designs and cost estimates of different elements of EST, with prototypes or component demonstrators where appropriate.
3) SOLARNET 312495: The main activities were: to provide international access to solar telescopes; to collect historical data and to provide them to the European community; to coordinate international observing campaigns; to develop prototypes of a new generation post-focus instruments.

ERASMUS+ projects:

1) ERASMUS+ project, European Collaborating Astronomer ProjectS: Espana-Czechia-Slovakia, No. 2020-1-CZ01-KA203-078200, 01.09.2020- 31.08.2023, total funding: 318 085 EUR, funding for institute: 49 992 EUR, M. Jakubík - Coordinator for Slovakia
2) ERASMUS+ project, Per aspera ad astra simul (Through difficulties to the stars together), No. 2017-1-CZ01-KA203-035562, 01.09.2017- 31.12.2020, total funding: 288 164 EUR, funding for institute: 40 116 EUR, J. Budaj - Coordinator for Slovakia

COST projects:

1) COST project, Origins and evolution of life on Earth and in the Universe, TD 1308, 15.05.2014-14.05.2018, total funding: 669 243 EUR, funding for institute: 2 666 EUR, Z. Kaňuchová - Coordinator for Slovakia

ESA PECS Programme:

1) ESA PECS project, Slovakia National Space Safety Programme (S2P) Study, ESA Contract No. 4000136251/21/D/AP, 10.12.2021-31.12.2022, total funding: 49 910 EUR, funding for institute: 7 216 EUR, M. Husárik – Work package leader

OTHER major international projects:

1) project ISITE-BFC, Integrated Quantum Information at the Nanoscale, No. ANR-15-IDEX-03, 01.03.2017- 30.09.2020, total funding: 1 036 EUR, funding for institute: 1 036 EUR, M. Saniga - Coordinator
2) BAYHOST project, SLOBATCO - Slovak-Bavarian Telescope Collaboration, No. MB-2018-2/11, 01.09.2018-31.10.2018, total funding: 3 000 EUR, funding for institute: 1 119 EUR, T. Pribulla - Coordinator
3) French Conseil Régional Research Project, Exploring the Geometry of Generalized Pauli Groups, No. RECH-MOB15-000007, 01.09.2015- 30.06.2016, total funding: 9 600 EUR, funding for institute: 9 600 EUR, M. Saniga – Coordinator
4) EU-7RP-SOLARNET project (Trans-national access and service programe: GREGOR), Magnetic and dynamical parameters of active region filaments, Ref. nr.: 16-01, 18.06.2016-26.06.2016, total funding: 38 196 EUR, funding for institute: 35 608 EUR, P. Gömöry - Coordinator,
5) EU-H2020-SOLARNET project (Trans-national access and service programe: GREGOR), Evolution of the vector magnetic field in an arch filament system, 08.07.2019-18.07.2019, total funding: 58 480 EUR, funding for institute: 56 907 EUR, S.J. González Manrique - Coordinator
6) EU-7RP-312495-SOLARNET project, Waves in fine-scale structures of the solar chromosphere, Ref. nr.: 16-08, 11.05.2016-19.05.2016, total funding: 25 191 EUR, funding for institute: 23 136 EUR, J. Koza - Coordinator

- **National projects, incl. international projects with only national funding**

2.4.2. List of ERA-NET projects funded from SAS budget

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2.4.3. List of projects of the Slovak Research and Development Agency, APVV

1) APVV project, From Interacting Binaries to Exoplanets, No. APVV-20-0148, 01.07.2021- 30.06.2025, total funding: 235 000 EUR, funding for institute: 134 580 EUR, T. Pribulla – Coordinator
2) APVV project, The relationship between color and polarization in comets: clues to understanding microphysical properties of cometary dust and mechanisms of its ejection, No. APVV-19-0072, 01.07.2020-30.06.2024, total funding: 130 000 EUR, funding for institute: 130 000 EUR, O. Ivanova - Coordinator
3) APVV project, Physical and dynamical characteristics of meteoroids, No. APVV-16-0148, 01.07.2017-30.06.2021, total funding: 210 000 EUR, funding for institute: 36 939 EUR, M. Hajduková - Investigator
4) APVV project, Interacting binaries - Key for the Understanding of the Universe, No. APVV-15-0458, 01.07.2016-30.06.2020, total funding: 206 214 EUR, funding for institute: 105 176 EUR, A. Skopal - Coordinator
5) APVV project, Model of meteoroid population in the close vicinity of the Earth, No. APVV-0517-12, 01.10.2013-30.09.2017, total funding: 206 625 EUR, funding for institute: 16 744 EUR, M. Hajduková – Investigator

2.4.4. List of projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education, VEGA (for funding specify only total sum obtained from all VEGA grants in particular year)

VEGA projects in 2021 - total budget: 59 775 EUR

1) VEGA project, Multifrequency research of accreting white dwarfs in cataclysmic variables, No. VEGA 2/0030/21, 01.01.2021-31.12.2024, A. Skopal - Coordinator
2) VEGA project, Investigation of the dynamic and magnetic properties of the structures in the solar atmosphere based on spectroscopic and spectro-polarimetric methods, No. VEGA 2/0048/20, 01.01.2020-31.12.2023, P. Gömöry - Coordinator
3) VEGA project, Generalized Incidence Geometries in Quantum Information and Astrophysics, No. VEGA 2/0004/20, 01.01.2020-31.12.2023, M. Saniga – Coordinator
4) VEGA project, Dynamics of the meteoroid streams of selected comets and other small objects in the Solar System, No. VEGA 2/0037/18, 01.01.2018-31.12.2021, L. Neslušan - Coordinator

5) VEGA project, Evolution, physical characteristics and interrelationships between populations of interplanetary matter, No. VEGA 2/0023/18, 01.01.2018-31.12.2021, J. Svoreň - Coordinator
6) VEGA project, Eclipses: basic tool to study exoplanets, binaries and multiple stellar system, No. VEGA 2/0031/18, 01.01.2018-31.12.2021, J. Budaj – Coordinator

VEGA projects in 2020 - total budget: 77 239 EUR

1) VEGA project, Investigation of the dynamic and magnetic properties of the structures in the solar atmosphere based on spectroscopic and spectro-polarimetric methods, No. VEGA 2/0048/20, 01.01.2020-31.12.2023, P. Gömöry - Coordinator
2) VEGA project, Generalized Incidence Geometries in Quantum Information and Astrophysics, No. VEGA 2/0004/20, 01.01.2020-31.12.2023, M. Saniga - Coordinator
3) VEGA project, Dynamics of the meteoroid streams of selected comets and other small objects in the Solar System, No. VEGA 2/0037/18, 01.01.2018-31.12.2021, L. Neslušan - Coordinator
4) VEGA project, Evolution, physical characteristics and interrelationships between populations of interplanetary matter, No. VEGA 2/0023/18, 01.01.2018-31.12.2021, J. Svoreň - Coordinator
5) VEGA project, Eclipses: basic tool to study exoplanets, binaries and multiple stellar system, No. VEGA 2/0031/18, 01.01.2018-31.12.2021, J. Budaj - Coordinator
6) VEGA project, Outbursts of cataclysmic variables, No. VEGA 2/0008/17, 01.01.2017-31.12.2020, A. Skopal – Coordinator

VEGA projects in 2019 - total budget: 81 667 EUR

1) VEGA project, Dynamics of the meteoroid streams of selected comets and other small objects in the Solar System, No. VEGA 2/0037/18, 01.01.2018-31.12.2021, L. Neslušan - Coordinator
2) VEGA project, Evolution, physical characteristics and interrelationships between populations of interplanetary matter, No. VEGA 2/0023/18, 01.01.2018-31.12.2021, J. Svoreň - Coordinator
3) VEGA project, Eclipses: basic tool to study exoplanets, binaries and multiple stellar system, No. VEGA 2/0031/18, 01.01.2018-31.12.2021, J. Budaj - Coordinator
4) VEGA project, Outbursts of cataclysmic variables, No. VEGA 2/0008/17, 01.01.2017-31.12.2020, A. Skopal - Coordinator
5) VEGA project, Dynamical and magnetic properties of active phenomena in the solar atmosphere – complex study, No. VEGA 2/0004/16, 01.01.2016-31.12.2019, P. Gömöry – Coordinator
6) VEGA project, Veldkamp Spaces in Quantum Information and Astrophysics, No. VEGA 2/0003/16, 01.01.2016-31.12.2019, M. Saniga - Coordinator

VEGA projects in 2018 - total budget: 73 549 EUR

1) VEGA project, Dynamics of the meteoroid streams of selected comets and other small objects in the Solar System, No. VEGA 2/0037/18, 01.01.2018-31.12.2021, L. Neslušan - Coordinator
2) VEGA project, Evolution, physical characteristics and interrelationships between populations of interplanetary matter, No. VEGA 2/0023/18, 01.01.2018-31.12.2021, J. Svoreň - Coordinator
3) VEGA project, Eclipses: basic tool to study exoplanets, binaries and multiple stellar system, No. VEGA 2/0031/18, 01.01.2018-31.12.2021, J. Budaj - Coordinator
4) VEGA project, Outbursts of cataclysmic variables, No. VEGA 2/0008/17, 01.01.2017-31.12.2020, A. Skopal - Coordinator
5) VEGA project, Dynamical and magnetic properties of active phenomena in the solar atmosphere – complex study, No. VEGA 2/0004/16, 01.01.2016-31.12.2019, P. Gömöry - Coordinator
6) VEGA project, Veldkamp Spaces in Quantum Information and Astrophysics, No. VEGA 2/0003/16, 01.01.2016-31.12.2019, M. Saniga - Coordinator

VEGA projects in 2017 - total budget: 70 266 EUR

1) VEGA project, Outbursts of cataclysmic variables, No. VEGA 2/0008/17, 01.01.2017-31.12.2020, A. Skopal – Coordinator

2) VEGA project, Dynamical and magnetic properties of active phenomena in the solar atmosphere – complex study, No. VEGA 2/0004/16, 01.01.2016-31.12.2019, P. Gömöry - Coordinator
3) VEGA project, Veldkamp Spaces in Quantum Information and Astrophysics, No. VEGA 2/0003/16, 01.01.2016-31.12.2019, M. Saniga - Coordinator
4) VEGA project, The meteoroid population, its origin, evolution and interaction with the Earth, No. VEGA 1/0225/14, 01.01.2014-31.12.2017, M. Hajduková - Investigator
5) VEGA project, Selected problems of the origin of some small-body groups in the Solar System, No. VEGA 2/0031/14, 01.01.2014-31.12.2017, L. Neslušan - Coordinator
6) VEGA project, Physical processes in interacting binaries and extrasolar planetary systems, No. VEGA 2/0143/14, 01.01.2014-31.12.2017, T. Pribulla – Coordinator
7) VEGA project, Analysis of dynamic and physical characteristics of interplanetary bodies in the vicinity of the Earth's path, No. VEGA 2/0032/14, 01.01.2014-31.12.2017, J. Svoreň – Coordinator

VEGA projects in 2016 - total budget: 75 561 EUR

1) VEGA project, Dynamical and magnetic properties of active phenomena in the solar atmosphere – complex study, No. VEGA 2/0004/16, 01.01.2016-31.12.2019, P. Gömöry - Coordinator
2) VEGA project, Veldkamp Spaces in Quantum Information and Astrophysics, No. VEGA 2/0003/16, 01.01.2016-31.12.2019, M. Saniga - Coordinator
3) VEGA project, The meteoroid population, its origin, evolution and interaction with the Earth, No. VEGA 1/0225/14, 01.01.2014-31.12.2017, M. Hajduková - Investigator
4) VEGA project, Selected problems of the origin of some small-body groups in the Solar System, No. VEGA 2/0031/14, 01.01.2014-31.12.2017, L. Neslušan - Coordinator
5) VEGA project, Physical processes in interacting binaries and extrasolar planetary systems, No. VEGA 2/0143/14, 01.01.2014-31.12.2017, T. Pribulla - Coordinator
6) VEGA project, Analysis of dynamic and physical characteristics of interplanetary bodies in the vicinity of the Earth's path, No. VEGA 2/0032/14, 01.01.2014-31.12.2017, J. Svoreň - Coordinator
7) VEGA project, Physical processes in symbiotic stars and novae, No. VEGA 2/0002/13, 01.01.2013-31.12.2016, A. Skopal - Coordinator

2.4.5. List of projects supported by EU Structural Funds

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2.4.6. List of other projects funded from national resources

SASPRO project:

1) SASPRO project, Investigation of development of the physical activity of dynamical new comets over the wide range of heliocentric distances, No. 1287/03/01, 25.02.2016-31.12.2018, total funding: 204 920 EUR, funding for institute: 204 920 EUR, O. Ivanova - Coordinator

Bilateral APVV projects:

1) APVV project Slovakia-France, Finite geometries shaping quantum information, No. APVV SK-FR-2017-0002, 01.01.2018-31.12.2019, total funding: 14 877 EUR, funding for institute: 9 960 EUR, M. Saniga - Coordinator
2) APVV project Slovakia-Austria, Coupling effects in solar atmosphere structures - high resolution approach, No. APVV SK-AT-2017-0009, 01.01.2018-31.12.2019, total funding: 8 000 EUR, funding for institute: 4 000 EUR, A. Kučera - Coordinator
3) APVV project Slovakia-Austria, Early evolution of CMEs and associated dimming regions, No. SK-AT-2015-0002, 01.01.2016-31.12.2017, total funding: 9 520 EUR, funding for institute: 4 000 EUR, P. Gömöry - Coordinator
4) APVV project Slovakia-Austria, Waves in fine-scale structures of the solar chromosphere, No. SK-AT- 2015-0022, 01.01.2016-31.12.2017, total funding: 8 056 EUR, funding for institute: 4 218 EUR, J. Koza - Coordinator
5) APVV project Slovakia-Portugal, Evolution of Solar Activity over a Solar Cycle – from Statistics to Physics, No. SK-PT-2015-0004, 01.01.2016- 31.12.2017, total funding: 2 700 EUR, funding for institute: 2 700 EUR, J. Rybák – Coordinator

Collaborative exchange projects of the Slovak Academy of Sciences (MAD projects):

1) Exchange project Slovakia-Czech Republic, Photometric and spectroscopic study of exoplanetary candidates, No. SAV-AV ČR-18-02, 01.01.2018-31.12.2021, total funding: 1 355 EUR, funding for institute: 1 355 EUR, Ľ. Hambálek - Coordinator
2) Exchange project Slovakia-Germany), Evolution pathways for blue horizontal branch stars, No. DAAD 57513233, 01.01.2020-31.12.2021, total funding: 344 EUR, funding for institute: 344 EUR, E. Kundra - Coordinator
3) Exchange project Slovakia-Czech Republic, Magnetoacoustic waves and dynamics of selected magnetic/plasma structures observed in solar active regions, No. SAV-AV ČR-18-01, 01.01.2018-31.12.2021, total funding: 4 246 EUR, funding for institute: 2 747, EUR, J. Rybák - Coordinator
4) Exchange project Slovakia-Czech Republic, Modelling of solar prominence fine structures using simultaneous SUMER and IRIS UV spectroscopy of hydrogen and magnesium lines, No. SAV-AV ČR-18-03, 01.01.2018-31.12.2021, total funding: 3 258 EUR, funding for institute: 1 808 EUR, P. Schwartz - Coordinator
5) Exchange project Slovakia-Germany, The dynamic and magnetic environment of arch filament systems, No. DAAD 57449420, 01.01.2019-31.12.2021, total funding: 14 934 EUR, funding for institute: 12 484 EUR, P. Gömöry - Coordinator
6) Exchange project Slovakia-Ukraine, Searching for giant exoplanets around White Dwarfs, 06.04.2017-31.12.2019, total funding: 1 326 EUR, funding for institute: 1 326 EUR, Z. Garai - Coordinator
7) Exchange project Slovakia-Ukraine, Physical processes in cataclysmic binaries, 06.04.2017-31.12.2019, total funding: 1 364 EUR, funding for institute: 1 364 EUR, D. Chochol - Coordinator
8) Exchange project Slovakia-Ukraine, Physical properties of cometary dust from photometric, spectral, and polarimetric observations, 06.04.2017-31.12.2019, total funding: 874 EUR, funding for institute: 874 EUR, O. Ivanova - Coordinator
9) Exchange project Slovakia-Czech Republic, The study of interplanetary matter in the Earth's vicinity, No. SAV-AV ČR 15-17, 01.01.2015- 31.12.2017, total funding: 4 836 EUR, funding for institute: 3 034 EUR, M. Husárik - Coordinator
10) Exchange project Slovak-Czech Republic, Diagnostics of solar coronal structures with impulsively generated magnetoacoustic wave trains (observations and numerical simulations), No. SAV-AV ČR-16-03, 01.01.2016-31.12.2017, total funding: 2 613 EUR, funding for institute: 1 916 EUR, J. Rybák – Coordinator
11) Exchange project Slovakia-Ukraine, Study of stellar explosions in interacting binaries, No. 1/2014, 08.10.2014-31.12.2016, total funding: 280 EUR, funding for institute: 280 EUR, D. Chochol - Coordinator
12) Exchange project Slovakia-Ukraine, The Dwarf project: Eclipsing binaries - precise clocks to discover exoplanets, No. 2/2014, 08.10.2014-31.12.2016, total funding: 280 EUR, funding for institute: 280 EUR, M. Vaňko - Coordinator

MVTS support for the international projects:

1) MVTS support, ERASMUS+ project - European Collaborating Astronomer ProjectS: Espana-Czechia-Slovakia, No. 2020-1-CZ01-KA203-078200, 01.09.2020-31.08.2023, total funding: 4 017 EUR, funding for institute: 4 017 EUR, M. Jakubík – Coordinator
2) MVTS support, H2020 project - Integrating High Resolution Solar Physics, No. H2020-INFRAIA-2018-2020 SOLARNET: 824135, 01.01.2019-31.12.2022, total funding: 14 150 EUR, funding for institute: 14 150 EUR, P. Gömöry – Coordinator
3) MVTS support, H2020 project - Preparatory Phase for the European Solar Telescope, No. H2020-INFRADEV-2016-2017 PRE-EST: 739500, 01.04.2017-30.09.2022, total funding: 16 950 EUR, funding for institute: 16 950 EUR, P. Gömöry – Coordinator
4) MVTS support, COST project - Origins and evolution of life on Earth and in the Universe, TD 1308, 15.05.2014-14.05.2018, total funding: 8 517 EUR, funding for institute: 8 517 EUR, Z. Kaňuchová – Coordinator
5) MVTS support, FP7 project - SOLARNET-High-Resolution Solar Physics Network, No. FP7-INFRA-312495, 01.04.2013-31.03.2017, total funding: 5 154 EUR, funding for institute: 5 154 EUR, A. Kučera – Coordinator

2.4.7. List of projects funded from private funds

The project was fuded from private funds which were provided after the successful application in the public call:

1) ESET foundation project „The universe is our home“, duration of the project: 15.05.2019-15.11.2019, total funding: 2 500 EUR, funding for the institute: 2 500 EUR, J. Svoreň – Coordinator

2.4.8. List of projects funded from other competitive funds

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2.5. PhD studies and educational activities

2.5.1. List of accredited programmes of doctoral studies, period of validity, source of funding

Before August 2019:

AI SAS organised doctoral studies in the programme called “Astronomy and astrophysics”. The accredited programmes were:

1) 4.1.7 astronomy,
2) 4.1.8 astrophysics

The doctoral studies were coordinated by the Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava. The funding was covered by internal funds of the Slovak Academy of Sciences.

After August 2019:

Due to legislative changes, AI SAS signed a new cooperation agreement with the Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava on the organisation of the doctoral studies. The studies are accredited in the study field “13. Physics”, study programme “Astronomy and astrophysics”. The agreement is not limited in time. Funding is covered by internal sources of the Slovak Academy of Sciences.

2.5.2. Summary table on doctoral studies (number of internal/external PhD students at the end of the year; number of foreign PhD students, number of students who successfully completed their theses during the year, number of PhD students who quit the programme during the year)

PhD study	2016			2017			2018			2019			2020			2021		
Number of potential PhD supervisors	14			14			14			15			15			16		
PhD students	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	unumber, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted
Internal total	3	1	0	2	0	3	4	0	0	4	0	0	3	0	1	3	1	0
from which foreign citizens	0	0	0	1	0	0	3	0	0	3	0	0	2	0	1	3	0	0
External	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other supervised by the research employees of the institute	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	1	0

2.5.3. PhD carrier path – Information on the next career steps of the PhD graduates who received their degree from the institute

PhD graduate name: RNDr. Zoltán Garai, PhD.

Z. Garai defended his PhD thesis in August 2016. After the defence, he got a temporal contract at the AI SAS. From January 1, 2020, until December 31, 2023, Z. Garai acts as a post-doc at the Gothard Astrophysical Observatory, Szombathely, Hungary. It is expected that Z. Garai will continue at the AI SAS after his post-doc stay in Hungary.

PhD graduate name: Mgr. Martin Benko, PhD.

M. Benko defended his PhD thesis in August 2021. He completed a long-term stay at the Instituto de Astrofísica de Canarias, Tenerife, Spain, during his PhD study. After the defence, he got a temporal contract at the AI SAS. Since January 1, 2022, he receives the Stefan Schwarz fellowship.

2.5.4. Summary table on educational activities

Teaching	2016	2017	2018	2019	2020	2021
Lectures (hours/year)*	208	225	226	259	369	121
Practicum courses (hours/year)*	81	96	48	91	0	42
Supervised diploma and bachelor thesis (in total)	2	4	5	5	5	7
Members in PhD committees (in total)	6	6	0	3	1	9
Members in DrSc. committees (in total)	3	0	0	0	0	0
Members in university/faculty councils (in total)	0	0	0	0	0	0
Members in habilitation/inauguration committees (in total)	4	7	0	1	0	0

2.5.5. List of published university textbooks

1) NESLUŠAN, Luboš. *Elementárny úvod do nebeskej mechaniky*. Bratislava : VEDA, vydavateľstvo SAV, 2017. 336 s. ISBN 978-80-224-1610-8

2.5.6. Number of published academic course books

-

2.5.7. List of joint research laboratories/facilities with universities

-

2.5.8. Supplementary information and/or comments on doctoral studies and educational activities – focused on what changes have occurred since the last evaluation in 2016

The detailed description of the main activities and changes in the doctoral studies performed at AI SAS since the last evaluation is provided in section 3 (point 1: Education) of this questionnaire.

Here, supplementary information to educational activities is provided:

1) Members of AI SAS participate in boards for the State exams at the Pavol Jozef Safarik University in Kosice and Comenius University in Bratislava,
2) Members of AI SAS participate in the Committee for defending of DrSc degree in astronomy and astrophysics,

3) Members of AI SAS participate in Committees for defending of PhD in astronomy and astrophysics,
4) AI SAS actively collaborates with the following national and international faculties: Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava; Faculty of Natural Sciences, UPJS in Kosice; Taras Shevchenko National University, Kiev, Ukraine; I. I. Mechnikov National University, Odessa, Ukraine; Technical University, Braunschweig, Germany; Université de Technologie Belfort-Montbéliard, Belfort, France.

2.6. Societal impact

2.6.1. The most important case studies of the research with direct societal impact, max. 4 for institute with up to 50 average FTE researchers per year, 8 for institutes with 50 – 100 average FTE researchers per year and so on. Structure: Summary of the impact; Underpinning research; References to the research; Details of the impact; Sources to corroborate the impact. One page per one case study

Summary of the impact: As set out in section 2.1.1, AI SAS is exclusively oriented on basic research. Therefore, all the scientific results achieved at the institute have predominantly the impact on general knowledge. Nevertheless, the institute provides service fundamentally important for the entire society in Slovakia. As this service has aspects of a case activity with “direct societal impact”, we provide the details about it in this section.

Details of the impact: The operation of all airports in Slovakia is regulated by the national law that, among other things, requires that information on precise times of sunrises and sunsets have to be available to all airport locations on a daily basis to guarantee the safety of passengers. This role is by law given to the Slovak Hydrometeorological Institute. However, currently it would be impossible to fulfill this task without knowledge and expertise only available at AI SAS. Therefore, AI SAS guarantees this service on the basis of a written contract with the Slovak Hydrometeorological Institute in the last years.

Underpinning research and references to the research: The societal impact described above is not based on any particular research output of AI SAS. However, it is based on the use of knowledge and many years of experience that only the AI SAS has at its disposal. AI SAS uses its computational facilities and own tools to determine individual times.

Sources to corroborate the impact: The contract between AI SAS and the Slovak Hydrometeorological Institute can be found at https://crz.gov.sk/4564117/. It provides information about the duties of AI SAS as well as the financial value of the contract.

2.6.2. List of the most important studies and/or other activities commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes (title, name of institution, contract value, purpose (max 20 words))

AI SAS members performed following activities for the decision-making authorities and are involved in the following formal bodies:

1) the expert member of "The national team of technical experts to assess the goods and dual-use technologies and military equipment" to the Ministry of Economy",
2) the representative of a full member of AI SAS in the "SANET – Slovak Academy Data Network", the strategic State consortium for development of Internet and network activities in Slovakia,
3) the expert member of The Steering Committee of the national project "Slovak grid infrastructure SlovakGrid",

4) a vice-chairman of the board of councils of "State program for science and research - Complex solution of support and the efficient use of infrastructure, research and development",
5) the expert for Assessment of findings "meteorites" and records of special flying bodies in the atmosphere" (overall 178 events in the evaluation period),
6) evaluation of a book translation entered in the competition for the Matej Bel Award for scientific and professional translation.

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues (study title, name of institution, contract value, country of partner, purpose (max 20 words))

AI SAS is the organisation exclusively aimed at basic research and it, therefore, does not have any contracts and research projects with industrial partners.

2.6.4.1 List of intangible fixed assets (internally registered IP (confidential know-how), patent applications, patents granted, trademarks registered) denoting background IPR

AI SAS is the organisation exclusively aimed at basic research and it, therefore, does not have any licences.

2.6.4.2 List of licences sold abroad and in Slovakia, incl. revenues (background IPR identification, name of institution, contract value, country of partner, purpose (max 20 words))

AI SAS is the organisation exclusively aimed at basic research and it, therefore, does not have any licences.

2.6.5. Summary of relevant activities, max. 300 words (describe the pipeline of valorization in terms of Number of disclosure, Number of registered IP internally, number of CCR/LIC contracts and their respective summary values, the support you are receiving in specific points internally at the institute, at SAS, externally – also the limitations and drawbacks.

Social impact of AI SAS is essential in enlightenment, edification and in popularization of science and technology, in education and motivation of the young generation for science and in transferring knowledge to society.

Next to standard activities mentioned above, AI SAS has to deal also with very curious activities related to, for example, explanation of unknown phenomena, especially, those that are associated with existence of UFO (Unidentified Flying Object). Detailed evaluation of each reported phenomenon brings a huge benefit in public education. Of course, in all cases we are dealing only with various optical, atmospheric and other physically justified phenomena (see Fig. 8). But they may appear as something unexplainable to the public. Without correct explanation of these phenomena, conditions for spreading of the manipulative questions and nonsense hoaxes are created. Thus, it is very important to contribute to education in this area.

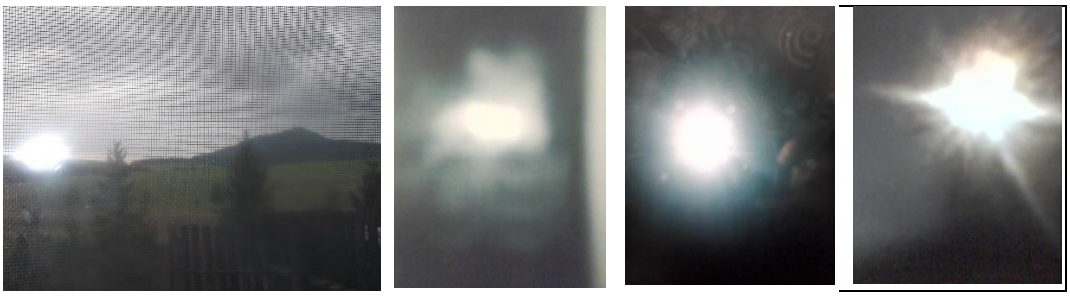


Figure 8: Photos of the “real UFOs” sent to the AI SAS by random observes who reported contacts with aliens. Obviously, all such photos show only reflections which are misinterpreted, thus confusing observers.

2.7. Popularisation of Science (outreach activities)

2.7.1. List of the most important popularisation activities, max. 20 items

AI SAS pays a lot of attention to popular-science activities which are directed towards the schools and interested public. They include lectures, open house activities, observations for public, workshops, exhibitions, popular articles, TV programmes and web-page information. In the assessment period, AI SAS performed more than 1400 outreach activities in Slovakia. More details are given in table 2.7.2.

Below, we provide a list of the selected events which demonstrate an impact of our popularisation activities to the public and proves an important contribution of AI SAS in general knowledge of the society. This represents one of the main societal and cultural impact of the institute even with potential economic aspects – the educated society is less probably affected by hoaxes.

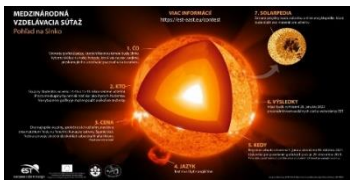
Public lectures:

1) „Comets after the Rosetta mission“, presented in a frame of „Košická vedecká kaviareň“, KulturFabrik Tabačka, Košice, February 26, 2020 (J. Svoreň)
2) „60 years of Cosmonautics“, presentation at EXPO 2020, Dubai, October 2021 (A. Kučera)
3) „The Sun – a star of life“, presented in a frame of „SAVinci - vedecká kaviareň“, Western Plaza, Bratislava, June 27, 2019 (P. Gömöry).
4) „Exoplanets are not sci-fi anymore“, presented in the frame of „Roadshow of young scientists of SAS“, schools in Košice and Poprad, Slovakia November 28, 2019 (Ľ. Hambálek)

TV programmes:

5) „Is our Sun a friendly star?“, episode of the Experiment – the talk show about science, broadcasted by Radio and Television of Slovakia (RTVS), October 4, 2021 (M. Jakubík, P. Gömöry),
6) „Mission DART“, episode of the Experiment – the talk show about science, broadcasted by Radio and Television of Slovakia (RTVS), November 29, 2021 (M. Husárik),
7) regular contributions to the evening news of the main TV channels in Slovakia

School Contest:



8) co-organisation of the „The Sun at a glance“, contest for the primary and secondary schools to create infographics about solar-related topics, in total 2859 students from 242 schools of 16 countries participated in the contest, the second prize winner: Gymnázium Varšavská, Žilina, Slovakia, June – December 2021,

Exhibitions and festivals of science:

9) the festival of science „Víkend so SAV“, a promotional-educational public street festival organized by SAS, Primaciálne námestie, Bratislava, Slovakia, September 7-8, 2018 and June 21-22, 2019 (V. Porubčan, M. Hajduková, J. Svoreň, D. Tomko, M. Vaňko, A. Kučera),
10) regular participation at the festival of science „Researcher’s Night“, performed activities: observations for public, presentation of the meteorites, exhibitions of astronomical instruments, scientific discussions, 2016-2021,

11) „Čarovný vesmír“, an exhibition in the shopping centre OC MAX, Poprad, Slovakia, 2021 (V. Rušin)
12) „EST – European Solar Telescope“, an exhibition in the main Aula of the Slovak Academy of Sciences, Bratislava, July 2019 (A. Kučera, P. Gömöry)

Observations for public:

13) „Večera pod hviezdami“, a public event co-organised with the private company Tatry Mountain Resort which operates cable cars to Skalnate Pleso and Lomnicky Stit, in total 25 events organised at the Skalnate Pleso in the period 2016-2021,
14) „Science and technology week in Slovakia“, night time observations accompanied with lectures and excursions, observing pavilon G2, Stará Lesná, 2016-2019 (2020-2021: only in the online form)

Open-door activities:

15) regular organisation of the open house activities at the observatories at Skalnate Pleso and Lomnicky Stit, these events provide a unique possibility for the public to enter observatories of AI SAS and to see the observational technique, in together 14 full days were dedicated to the activitiy in the period 2016-2019,

Honourable visits:

16) visit of Her Excellency Zuzana Čaputová, President of the Slovak Republic, together with 11 accompanying persons, at the Lomnicky Stit observatory, July 25, 2020,
17) visit of Maroš Šefčovič, the European Commission Vice-President for the Energy Union and EU Space Policy, at the Lomnicky Stit observatory, November 6, 2017,
18) visit of Kip Thorne, a Nobel laureate in physics, at the Lomnicky Stit observatory, October 17, 2021,
19) other important visits at the Lomnicky Stit observatory: the Slovak Republic ambassador in United Kingdom (October 12, 2019), representatives of the Ministry of finances of the Slovak and Czech Republic (March 21, 2019), representatives of the V4 countries (June 19, 2019), minister of finances of the Slovak Republic (July 5, 2019),
20) visit of the representatives of the National banks of Slovak and Czech Republics at the Skalnate Pleso observatory, June 1, 2019.

2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2016	2017	2018	2019	2020	2021	total
Articles in press media/internet popularising results of science, in particular those achieved by the Organization	67	77	73	207	209	197	830
Appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	35	26	32	17	47	28	185
Public popularisation lectures	84	80	72	87	25	26	374

2.8. Background and management. Infrastructure and human resources, incl. support and incentives for young researchers

2.8.1. Summary table of personnel

2.8.1.1. Professional qualification structure (as of 31 December 2021)

	Degree/rank				Research position		
	DrSc./DSc	CSc./PhD.	professor	docent/ assoc. prof.	I.	II.a.	II.b.
Male	5	21	0	1	5	13	6
Female	0	6	0	0	0	3	2

I. – director of research with a degree of doctor of science/DrSc.

II.a – Senior researcher

II.b – PhD holder/Postdoc

2.8.1.2. Age and gender structure of researchers (as of 31 December 2021)

Age structure of researchers	< 31		31-35		36-40		41-45		46-50		51-55		56-60		61-65		> 65	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Male	1,0	1,0	2,0	2,0	3,0	3,0	6,0	6,0	2,0	2,0	3,0	3,0	2,0	2,0	6,0	6,0	5,0	1,9
Female	0,0	0,0	0,0	0,0	1,0	1,0	2,0	2,0	0,0	0,0	1,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0

A – number

B – FTE

2.8.2. Postdoctoral fellowships (list of positions with holder name, starting date, duration. Add brief information about each fellow's career path before and after receiving PhD degree, etc.)

2.8.2.1. MoRePro and SASPRO fellowships

SASPRO fellowship:

1) Oleksandra Ivanova, PhD. – starting date: 25.02.2016, duration: 2 years and 311 days (31.12.2018). O. Ivanova defended her PhD thesis in 2004 at the Main Astronomical Observatory of National Academy of Sciences of Ukraine (MAO NASU, Kyiv, Ukraine). Before receiving PhD, she finished her master study at the Taras Shevchenko National University of Kyiv (Kyiv, Ukraine) in 2001. After

receiving PhD, she worked as a researcher at MAO NASU (Kyiv, Ukraine). From January 1st, 2019 she works at AI SAS as a senior researcher.

2.8.2.2. Stefan Schwarz fellowships

1) Sergio Javier González Manrique, PhD. – starting date: 1.6.2018, duration: 2 years (31.05.2020). S.J. González Manrique defended his PhD thesis in 2017 at the University of Potsdam (Potsdam, Germany). Before receiving PhD, he finished his master study at the Universidad de La Laguna (Tenerife, Spain) in 2011. After receiving PhD, he worked as a scientific researcher at the Leibniz-Institute for Astrophysics Potsdam (Potsdam, Germany). From September 1st, 2017 he worked as researcher at AI SAS. From June 2020 to January 2022, he worked as a postdoctoral researcher at the Instituto de Astrofísica de Canarias (La Laguna, Tenerife, Spain) and from February 2022, he works as a postdoc at the Leibniz Institute for Solar Physics (Freiburg, Germany). He still has a working contract at AI SAS during the post-docs stays.
2) Mgr. Peter Zelina, PhD. – starting date: 1.6.2019, duration: 2 years (31.07.2021). P. Zelina defended his PhD thesis in 2017 at the University of Central Lancashire (Preston, United Kingdom). Before receiving PhD, he finished his master study at Masaryk University (Brno, Czech Republic) in 2013. After receiving PhD, he worked as a research assistant at the University of Central Lancashire (Preston, United Kingdom) until May 2018. From January 1st, 2019 he worked as a researcher at AI SAS until August 31, 2021.

2.8.2.3. Postdoctoral positions from other resources (specify)

-

2.8.3. Important research infrastructure introduced during the evaluation period with the information about the sources of funding *(max. 2 pages)*

At AI SAS, unprecedented improvements of the research infrastructure were achieved during the previous evaluation period (2012-2015). This was made possible by support from the EU Structural Funds. The received financial support was roughly equal to the standard annual investments provided during 100 years. Thus, AI SAS has been equipped with the modern observational and technical infrastructure including fiber optics. Therefore, during a recent evaluation period, the main focus was given on the full implementation of the existing devices into optimal operation rather than acquiring a new instrumentation. Of course, several ancillary devices necessary for correct performance of the existing infrastructure were obtained exclusively using project resources.

During the period 2016-2021, a separate but equally important task was given priority, i.e., maintenance of observatory buildings and reconstruction of the public spaces in the headquarters. Although it looks that this task does not have any direct effect on the scientific output of the institute, a suitable and pleasant working environment is an important factor influencing work performance. Thus, it must be natural part of the development of the institute. It is important to note here that most of the maintenance works were carried out thanks to the significant support of the SAS Presidency.

As an example, the following list is provided:

- complex reconstruction of the 80-year old domes and the roof of the Skalnate Pleso Observatory started in 2021; it represents a total investment of 501 442 Euro,
- the bathroom at the Lomnicky Stit Observatory was completely reconstructed,
- the heating system at the Lomnicky Stit Observatory was significantly renewed,
- the kitchens and corridors of the headquarters were renovated,
- the floors in the offices were repaired,
- key servers of the institute have been replaced by more powerful machines,
- new polarimetric and interference filters were obtained for observations of comets and asteroids at the Skalnate Pleso Observatory,
- optical components to improve existing spectroscopes were purchased.

2.9. Supplementary information and/or comments on all items 2.1 – 2.8 (max. 2 pages in total for the whole section)

The information provided in sections 2.1 – 2.8 illustrates that the institute has improved in key parameters during the period under review compared to previous periods. To prove that this statement is correct, we use the most relevant measures of the relevance of the basic research – number of scientific papers registered in the Current Contents Connect (CC publications) and number of citations. The graphs displayed at Fig. 9 demonstrates a very positive trend in both measures. In the case of CC publications (Fig. 9, top panel), ***the maximum values achieved in the previous assessment period correspond to the minimum values achieved during the current assessment period*** (see the dashed red line in the top panel of the Fig. 9). And with regard to citations (Fig. 9, bottom panel), ***a significant increase in the number of citations is clearly visible during the period under review with respect to previous years*** (see the red line in the bottom panel of the Fig. 9). It is also important that the ratio between „relevant“ and „other“ citations“ is still very positive.

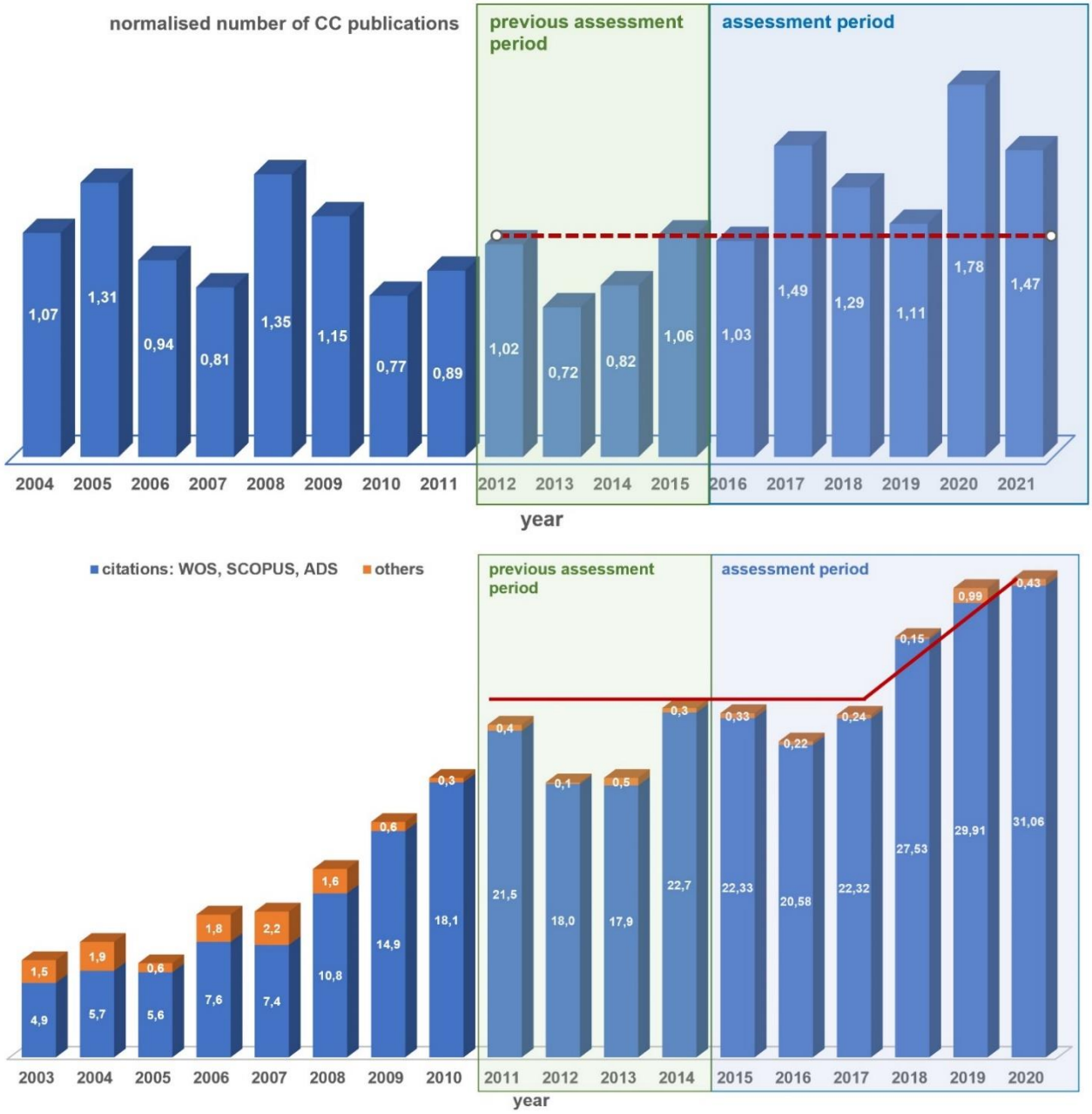


Figure 9: Positive trends in the number of CC publications (top panel) and number of citations (bottom panel) achieved at the AI SAS during the assessment period. Values displayed at both graphs are normalised to the FTE of researchers in the particular year. The top panel clearly shows that the maximum values achieved in the previous assessment period correspond to the minimum values achieved during the current assessment period. The bottom graph documents an increase in the number of “relevant” citations (WOS, SCOPUS, ADS) in the assessment period, while the "others" (less important citations) are negligible.

3. *Implementation of the recommendations from the previous evaluation period*

All recommendations from the previous evaluation were carefully considered and taken into account at AI SAS. Below, the recommendations are listed in red and the performed steps in black coloured text.

1) Education:

Education reported concerns the PhD level. The number of PhD students is, compared to the total number of research staff, astonishingly small.

We fully agree that the number of PhD students is a crucial factor for the future perspective of AI SAS and that it is important to increase the number of PhD students at a given time. Therefore, we have paid special attention to this problem in previous years.

As a first step, we identified the main reason for the decrease in the number of PhD students over time. It was found out that the overall number of students in physics and related fields is decreasing in Slovakia. This affects also astronomy and astrophysics. Moreover, AI SAS competes for students with two Universities (Comenius University, the Pavol Jozef Safarik University), which provide the opportunity for PhD studies in astrophysics. As a solution, AI SAS performed several actions (listed below) to attract PhD students from abroad.

The first step was based on personal contacts of the AI SAS staff at institutes abroad. This was used mainly to test the attractivity of the PhD studies at AI SAS for students from different countries (with respect to provided PhD topics and scholarship). After very positive experience with this approach, which led to the first foreign PhD students at the institute, the topic was very extensively discussed within the Scientific Board of AI SAS. As a result, the Scientific Board adopted the resolutions that a) each topic for the PhD thesis has to be submitted in English, and b) the topics have to be advertised on the EURAXESS platform to guarantee their higher visibility (independently, the PhD topics are advertised also on the web of Slovak Academy of Sciences). This led to significant increase of the received applications for PhD study at AI SAS with respect to previous years. Thus, AI SAS plans to continue in this approach.

In parallel, AI SAS has participated in the two Erasmus+ projects (see section 2.4.1) in order to improve the conditions and to increase the attractivity of the PhD studies for foreigners. The projects allow short and long term stays of the PhD students at partner institutions. This increases significantly the level of PhD education at AI SAS and thus leads to a higher degree of competitiveness of the PhD students in the European space.

As a consequence, all PhD students working at the AI SAS at the end of December 2021 are from abroad. But it must be admitted here that their number is still low. However, it is certainly only a temporary phenomenon that will be eliminated over time.

Although the focus on students from abroad has many positive aspects there is also a problematic point in admitting foreign students (especially students from third countries) in Slovakia. It is related to high bureaucracy and to the extremely time-consuming process necessary to obtain official permits needed to start PhD studies in Slovakia. The help at the level of Academy would be very beneficial here.

2) National Observing Facilities:

It is recommended to maintain national facilities at internationally competitive levels.

… on the other side, also necessitates often painful decisions regarding de-commissioning of facilities more cumbersome and expensive to operate than useful in terms of high-quality science output.

Regarding the instrumentation operated at the AI SAS, a lot of attention is paid to its efficient use with emphasis mainly on the equipments recently obtained for the observatories at the Lomnicky Stit (LSO) and Skalnate Pleso (SPO) from the EU Structural Funds. In recent years, LSO instruments have been repeatedly involved in the international campaigns together with the European largest solar telescope (GREGOR, Tenerife, Spain) and newest solar satellites (IRIS, Hinode, SDO). In case of SPO, participation in international observation campaigns has resulted in, among other things, the publication of original scientific work in the Nature journal (title: The size, shape, density and ring of the dwarf planet Haumea from a stellar occultation, 2017, Nature, vol. 550, No. 7675, pp. 219-223, IF2016 - 40.137). AI SAS plans to focus on the recently obtained

facilities located at the LSO and SPO also in the future. To do so, the improvement of the technical conditions of observatories at Skalnate Pleso and Lomnicky Stit is of high priority at AI SAS. This is, for example, documented by extensive reconstruction of the roof and domes at SPO which is recently in process (total costs: 0,5 M€, see section 2.8.3) or ongoing repair works on LSO. These works are possible only because extensive support directly from the Academy.

The extensive and very difficult discussion was performed within the Scientific Board concerning the "facilities more cumbersome and expensive to operate then useful in terms of high-quality science output". The discussion was initiated by the director of the institute and it took more than six months. As a result, the Scientific Board adopted the resolution that one of the 60-centimeter telescopes in close vicinity of the institute is decommissioned with an immediate effect. The operation of the second telescope of the same size will be gradually reduced. The telescope will be decommissioned within five years. These decisions were accepted in the broader context. The decommissioning of selected instruments will allow us to focus available manpower on the more modern instruments operated at the SPO. This will certainly be beneficial for improving the scientific output of the institute in the future.

3) Slovak Astronomy in an International Context:

Collaboration: It should be natural to collaborate closely with colleagues not only from the vicinity but from all of Europe and the world beyond. …. While today most non-Slovak collaborators come from neighbouring countries, a wider market should be actively attempted.

Following this recommendation, AI SAS intensified the cooperation with new foreign partners. In recent years, we have begun new collaboration with universities from France, Germany and Ukraine. We have signed a bilateral cooperation agreement with the Purple Mountain Observatory (Chinese Academy of Sciences, for the years 2020-2022), with the Institute of Astrophysics of the Academy of Sciences of the Republic of Tajikistan (since 2018). AI SAS participated actively also on the critical science plan for the Daniel K. Inouye Solar telescope (DKIST, the 4-metre aperture solar telescope) and on the development of the Science Requirement Document for the European Solar Telescope (EST, the planned 4-metre aperture solar telescope that is included in the ESFRI roadmap), i.e., activities involving the community of the solar physicists from all over the world. AI SAS was involved also in the large Outer Solar System Origin Survey (OSSOS) which was considered as a top ranked program for the Canada-France-Hawaii Telescope (aperture 3,6 m). The acquired observations were partially analysed at our institute. The results led to the discovery of more than 1000 new trans-Neptunian objects (TNO's) with high-precise orbits and dynamical classification. Among other applications, new TNO's orbits were used as an important sample to provide constraints for the extreme TNO's population, which serves as a sample for indirect evidence of hypothetical Planet IX detection. More than 40 scientists from institutes in eight countries from all over the world were involved in this project.

4) Slovak Astronomy in an International Context:

Recommendable is a timely assessment of the value of ESO and ESA membership, in the latter case extending the associate partnership.

AI SAS intensively supports membership of Slovakia in ESO and ESA, as such membership would certainly be beneficial for the scientific improvement of the institute. For this reason, the institute gladly received the information that Slovakia becomes an associate member of ESA. We are also actively applying for ESA projects, although most of the calls are oriented on applied science. Recently, one ESA project entitled "Slovakia National Space Safety Programme (S2P) Study" is running at the institute (see also section 2.4.1, part ESA PECS Programme).

The membership in ESO would be important for the whole Slovak stellar community. Unfortunately, AI SAS does not have any possibility to directly affect this process.

5) Astronomy and Physics:

It should be natural to link astronomy as well as possible with physics, both laboratory and theoretical.

The link between astrophysics and physics on both laboratory and theoretical levels is gradually developing at AI SAS. New research field based on laboratory spectroscopy applied on astrophysical objects can serve as an example. As a case study, mid-infrared and vacuum UV spectroscopy of thermally processed and electron irradiated CO_2 astrophysical ice analogues

was performed. Thermal oxidation of H_2S was studied with the direct implication for the surface composition of the Europa moon. Also the origin of molecular oxygen on the surface of the Ganymede was studied.
The theoretical works are focused mainly on the investigation of relativistic objects. The properties of these compact objects are described using general relativity equations without constraints.
Another type of promising theoretically-oriented research applies some concepts from quantum information theory to astrophysics, e.g., the so-called black-hole/qubit correspondence, and employs the formalism of multi-qubit symplectic polar spaces (and associated Veldkamp lines) to properly understand the structure of functionals used in form theories of gravity and black hole entropy.
But the research fields described above are still based on single-person activity. AI SAS plans to support their further development.

6) Human resources:
The ratio of women to men with research positions is, regrettably, a serious problem in many institutes in great parts of the world. In Slovak astronomy, this ratio is, regarding leading staff positions, alarming. Concerning the reasons for this serious situation, no clue is provided. It is most strongly recommended to study possible causes and to introduce remedial actions Such actions are no doubt strong contributions to quality assurance.
We are aware of this problem and we identified the main reasons of this situation. Currently, the study of astronomy and astrophysics in Slovakia is mostly performed by men and the representation of women in this area is minimal. This is subsequently reflected in the ratio of women to men in scientific positions at the institute.
To emphasis the same rights and approach to both genders at AI SAS, we have participated in the process of implementation of the HRS4R (Human Resources Strategy for Researchers) award at the institute. In addition, AI SAS has subscribed to the Gender Equality Plan of the Slovak Academy of Sciences. And of course, the standard principle of work in the institute is adherence to the rules of gender equality.
Concerning the leading positions at the AI SAS (director, head of the department), the rules for applying and obtaining a given position are strictly conditioned by qualitative indicators. The administrative section of AI SAS is lead by a woman.

4. ***Research strategy and future development of the institute for the next five years*** (Recommended 3 pages, max. 5 pages)

Research strategy of the institute in the national and international contexts, objectives, and methods (including the information on when the strategy was adopted)

Research strategy and the future development of the institute is on one side naturally based on the traditional scientific disciplines performed at the institute. On the other hand, new fields (e.g., “laboratory astrophysics”, see also Part 3 of this questionnaire) are supported and step-by-step integrated into the scientific structure of the AI SAS. In both cases, the main criterion determining the support for the particular scientific field is the necessity to use either experimental data of the highest quality or modern interpretational tools for numerical modelling and/or simulation.
To ensure that the mentioned criterion is really applied in practice, AI SAS has a system of planning and managing the development of its scientific focus. The system is based on the three pillars that are interconnected and all together provide a robust tool to guarantee that the institute will continue to pursue excellent science and produce relevant scientific results and publications. They can be summarised as follow:

1) a system of the complex evaluation of the scientific fields and scientists – expected outcome: recommendations directed to the individual researcher,
2) an action plan of the institute – the expected outcome: general recommendations for the institute as a whole,

3) motivation – the expected outcome: to provide a means for sustainability and further development of the recommendations provided in steps 1 and 2.

1) Complex evaluation of the scientific fields and scientists:

The Scientific Board of AI SAS performs the evaluation of all scientific fields existing at the institute at the given time. The evaluation is made with a 5-year periodicity and it was for the first time performed in 2005. The most recent evaluation was performed in the winter 2016 for the time interval 2017-2021 (i.e., covering most of the current evaluation period) and it reflected results of the international accreditation of the institute (based on the period 2012-2015). The evaluation has fixed rules and the main emphasis is given on: "significance of the performed science within the research field in Europe", "proposed strategies and methods to be applied within the planned research" and "main goals for a 5-year period". As a result of the last evaluation, following research areas are supported at AI SAS:

- extrasolar planets, brown dwarfs and low mass stars,
- physical processes and active events in the solar atmosphere,
- dynamical evolution of the small bodies in the Solar System,
- classic double-stars and multi-object systems,
- symbiotic stars and novae,
- meteoroid streams and clusters of the small bodies in the Solar System – evolution and physical characteristics of parental bodies.

The results of the last evaluation will be reconsidered in 2023 with respect to recommendations of the current accreditations. It is planned to implement all given suggestions.

Moreover, the existing system of evaluation is under reconsideration right now. Originally, the evaluation is performed by members of the Scientific Board where majority is from AI SAS. This approach had its historical justification and the evaluation in its current form had an extremely positive impact on the quality of science performed at the institute. Nowadays, evaluation based on the international body is considered and it will be discussed within the Scientific Board of AI SAS. This change will provide the important insight from outside of the institute and it will bring new and modern ideas how to proceed in the future and to keep the high scientific level of the institute.

As an independent body, AI SAS creates an international evaluation committee (details are given in section 1.4.1). This committee is responsible for the periodical evaluation of the scientists at AI SAS with the main goal to provide valuable recommendations how to improve their scientific career. The evaluations are performed every five years for the whole scientific staff and every time when a temporarily limited contract of a scientist is finishing. The international composition of the committee guarantees a very high level of evaluation, the advices based on European standards in the particular research field, but also direct identification of the potential negatives. The result of evaluation sometimes leads even to reduction of the next contract. This is a very painful consequence but it helps to improve future output of the institute. Thus, we plan to continue to implement it.

The third kind of evaluation of the scientific staff is made by the director of the institute every year. The evaluation is based on the inputs provided by each scientist of AI SAS to the Annual report of the institute. The final result of this evaluation is significant for consideration of the incentive payments and/or extra payments at the end of the year.

All the evaluations described above have their fixed rules which are available in the written form and they are discussed with the scientific staff of the institute. It is indisputable that their application helps to improve the scientific level of scientists at AI SAS and therefore we plan to use them also in the future.

2) The Action plan of AI SAS:

The Action plan of AI SAS was approved in 2017. It contains main measurable criteria and recommendations which should improve excellence of the science at the institute and strengthen the current leading position of AI SAS in astronomy and astrophysics in Slovakia. The outputs are controlled every year in the Annual report of the institute and thus they are available for the Presidium of the Academy.

Here, we would like to focus on one aspect how the implementation of the Action plan leads to measurable improvement of the scientific outputs of AI SAS.

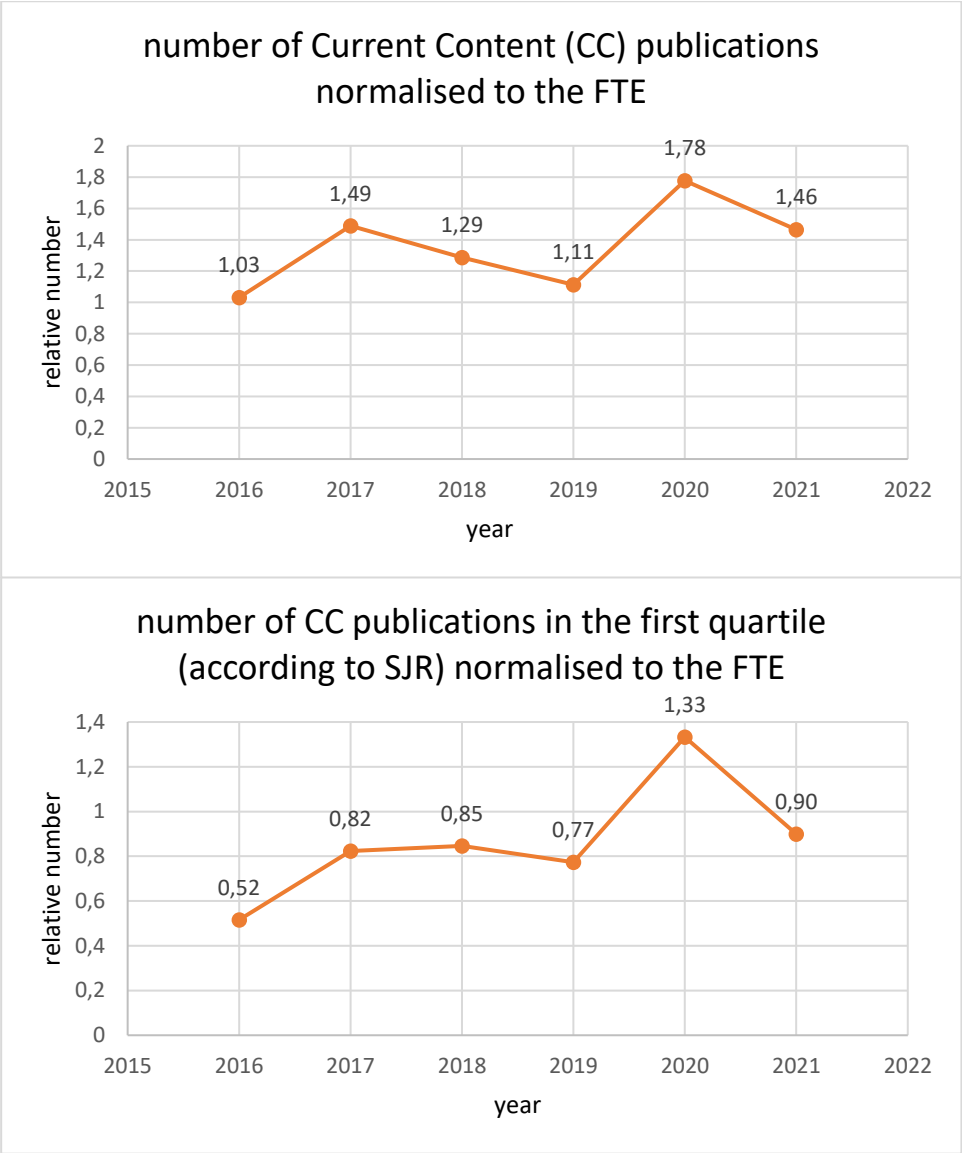


Figure 10: Top: Number of Current Content (CC) publications normalised to the FTE of the AI SAS researchers over the evaluating period. Bottom: The same as before but for the CC publications in the first quartile according to the Scimago Journal Ranking.

The main points of the Action plan are:

- to reach a stable publication activity at the minimum level of one Current Content (CC) publication per researcher (recalculated to the fulltime equivalent work capacity – FTE),
- increase the number of CC publications in the first quartile according to the Scimago Journal Ranking (SJR).

The top graph in Figure 10 shows the normalised (to the FTE of researchers) number of the CC publications over the evaluating period. Although the numbers are rather scattered and a longer time interval is needed to identify a potential trend (increase/decrease), it is obvious that more than one CC paper per FTE of AI SAS researcher is published. On the other hand, a clear trend is visible in the normalised number of CC papers published in the first quartile according to the SJR (Figure 10, bottom graph). The increase is visible in 2017 and it stays constant over the evaluating period (if we do not consider extreme increase in 2020).

The clear increase in the number of the top ranked publications affected another important parameter – the number of the citations indexed in the WoS and SCOPUS databases. Figure 11 shows that the normalised number of the citations starts to increase in 2017 but clearly in 2018 and the positive trend continues until 2020. This confirms that the Action plan of AI SAS is important and its application helps to improve the quality of science at our institute. Because of this, we plan to update relevant parts of the Action plan after the current accreditation and follow it also in the future.

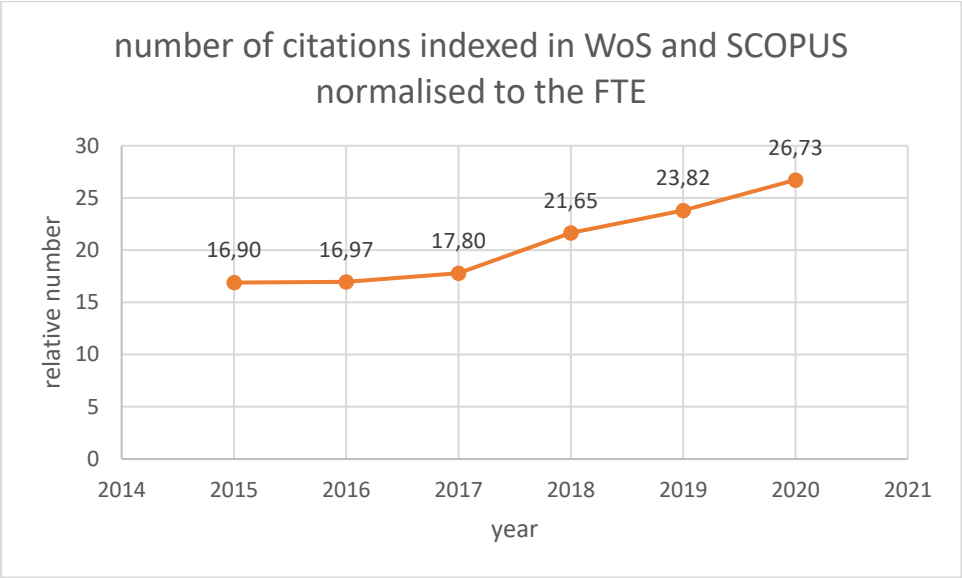


Figure 11: Normalised (to the FTE) number of the citations indexed in the WoS and SCOPUS databases over the evaluating period.

Motivation:

In order to motivate researchers at AI SAS to contribute as much as possible to high scientific standard of the institute, the internal system of following written rules is applied:

- to have the additional monthly payments: researchers have to publish on average three CC papers over the last three years,
- special bonus is paid every year, its estimation is based on the Impact Factor of the papers published by a particular researcher,
- special bonus is paid after a successful application for an international or APVV project,
- special bonus is paid to the supervisor after successful PhD defence of a student,
- special bonus is paid for teaching at universities,
- the possibility of changing a time-limited contract to a permanent one in case of high-quality scientific results.

We believe that the system described above is a guarantee of scientific improvement and further development of AI SAS in the future. The scientific direction of the institute is not left to chance, the researchers are regularly evaluated and their further work is guided by the international evaluation committee and the leading researchers are regularly financially rewarded. This creates a basic framework for the further successful development of individual researchers and thus the institute as a whole. By continuing to apply this system in the future, AI SAS will

- focus on publishing of the original scientific discoveries in the top ranked international journals, which would essentially lead to further increase in the number of citations,
- apply for international projects to even more strengthen existing international collaborations and to create new contacts with partners from abroad,
- keep the already established strategy to access foreign students (advertising the PhD topics at the EURAXESS platform) and perform further necessary steps to identify new methods to attract PhD students,
- naturally continue in the extensive service for the public in the terms of wide popularization activities (lectures for the public, collaboration with massmedia, contributions to printed media).

Tatranská Lomnica; June 30, 2022

Mgr. Peter Gömöry, PhD.
director of the Institute

Annex 1: European Solar Telescope as an ESFRI project in the section „Physical Sciences and Engineering“

1

ESFRI PROJECTS

	NAME	FULL NAME	ROADMAP ENTRY (YEAR)	OPERATION (YEAR)	LEGAL STATUS (AS OF 10 MARCH 2016)	CONSTRUCTION COSTS (M€)	OPERATIONAL ANNUAL BUDGET (M€/YEAR)
ENERGY	**ECCSEL**	European Carbon Dioxide Capture and Storage Laboratory Infrastructure	2008	2016	ERIC under preparation	80-120	1**
	EU-SOLARIS	European SOLAR Research Infrastructure for Concentrated Solar Power	2010	2020*	ERIC under preparation	120	3-4
	MYRRHA	Multi-purpose hYbrid Reactor for High-tech Applications	2010	2024*		NA	100
	WindScanner	European WindScanner Facility	2010	2018*		45-60	8
ENVIRONMENT	**ACTRIS**	Aerosols, Clouds and Trace gases Research Infrastructure	**2016**	2025*		190	50
	DANUBIUS-RI	International Centre for Advanced Studies on River-Sea Systems	**2016**	2022*		222	28
	EISCAT_3D	Next generation European incoherent scatter radar system	2008	2021*		74	6
	EPOS	European Plate Observing System	2008	2020*	ERIC under preparation	53	15
	SIOS	Svalbard Integrated Arctic Earth Observing System	2008	2020*		80	2-3
HEALTH & FOOD	**AnaEE**	Infrastructure for Analysis and Experimentation on Ecosystems	2010	2018*		200	2-3**
	EMBRC	European Marine Biological Resource Centre	2008	2016	ERIC under preparation	4,5	6
	EMPHASIS	European Infrastructure for multi-scale Plant Phenomics and Simulation for food security in a changing climate	**2016**	2020*		73	3,6
	ERINHA	European research infrastructure on highly pathogenic agents	2008	2018*		NA	NA
	EU-OPENSCREEN	European Infrastructure of Open Screening Platforms for Chemical Biology	2008	2018*	ERIC under preparation	7	1,2
	Euro-BioImaging	European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences	2008	2017*	ERIC under preparation	NA	1,55
	ISBE	Infrastructure for Systems Biology Europe	2010	2018*		30	7,2
	MIRRI	Microbial Resource Research Infrastructure	2010	2019*		6,2	1
PHYSICAL SCIENCES & ENGINEERING	**CTA**	Cherenkov Telescope Array	2008	2023*		297	20
	EST	European Solar Telescope	**2016**	2026*		200	9
	KM3NeT 2.0	KM3 Neutrino Telescope 2.0: Astroparticle & Oscillations Research with Cosmics in the Abyss	**2016**	2020*		92	3
ON	**E-RIHS**	European Research Infrastructure for Heritage Science	**2016**	2022*		4	5