Evaluation of research and professional activity of research-oriented institutes of the Czech Academy of Sciences for the period 2015–2019

Final Report

Name of the Institute: Astronomical Institute of the CAS, v. v. i.

Evaluated teams and their leaders:

1. Department of Solar Physics - Team 1 (Miroslav Bárta)
2. Department of Stellar Physics - Team 2 (Brankica Kubátová)
3. Department of Interplanetary Matter - Team 3 (Pavel Spurný)
4. Department of Galaxies and Planetary Systems - Team 4 (Richard Wünsch)

Part A: Evaluation of the institute

Strengths:

The Astronomical Institute of the Czech Academy of Sciences (CAS/ASI) is the largest professional institution in the country which focuses on astronomy and astrophysics. It represents science domestically in the Czech Republic and abroad towards international organizations. It is a very active place for up-to-date research with several national and international collaborations. Its national partners are the country‘s main universities (Prague, Brno and Opava), where CAS/ASI staff help teaching some specialized courses and whence most of the CAS/ASI-trained PhD students come from. CAS/ASI participates in a number of world- and European-level ground-based and space-borne projects (many coordinated by ESO or ESA). In several such cases, work opportunities have arisen for Czech high-tech companies. Decades of research, combined with new observational and theoretical advances, are a major asset of CAS/ASI. In several fields, e.g. active solar phenomena, early-type stars, and meteor astronomy, ASI has long reached world recognition. New topics, e.g. galactic astronomy, high-energy astrophysics & relativistic astrophysics and exoplanets, are being pursued with success. 60% of the CAS/ASI staff being younger than 45 is a clear asset for the future.

Weaknesses:

There are no major weaknesses to be reported. Smaller issues are: (i) ability of CAS/ASI to keep young promising researchers offering them permanent positions; (ii) making large on-site instruments (i.e., the 2-m telescope) more cost effective; (iii) improvement of gender balance in the institute as a whole and in individual teams. As to (i), efforts should be intensified to access national and European grants, and to obtain institutional support from CAS. As to (ii), a dedicated expert committee may suggest the best strategy. As to (iii) the planned/ongoing engagement with relevant European processes should be continued, gender distributions across all teams need to be monitored and a proactive recruitment strategy for the whole institute should be developed (e.g. contacting qualified women applicants for open positions).

Opportunities:

Involvement in large ESO and ESA projects allows participation in cutting-edge world-class research.

Threats:

A significant and growing fraction of grant funding poses a risk factor to the inception of new science programs and the continuation of existing ones. In particular, hiring technical staff for space research is vital to Czech participation in ESA projects but is threatened by uncertain funding. The healthy presence of many foreign nationals postdocs at CAS/ASI rests on the institute’s ability to attract personnel grants suitable to offer internationally competitive wages: this asset, too, may be jeopardized by uncertain funding. It is important for the leadership to weigh risks and opportunities of further investment against current commitments and financial risks to not overstretch resources.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
Results presented in Phase I-selected outputs are published in well-known, peer-reviewed journals (*Astrophysical Journal*, *Astronomy & Astrophysics*, *Monthly Notices of the Royal Astronomical Society, Solar Physics*). Some spectacular results of wider appeal are published on *Science* and *Nature*. Such publication success testifies the quality of the results obtained by CAS/ASI scientists in 2015-2019.	
H1.2	**Contribution of workers on the outputs reached**
CAS/ASI scientists are first or corresponding authors of most of the papers. Many papers are authored by CAS/ASI-only members.	
H1.3	**Quality of all outputs and results**
See H1.1.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Several results were published in 2015-2019. To name just a few highlights: the umbra/penumbra border line in sunspots may highlight a sharp transition between two zones of magnetic convection regime; the fine structure of prominences calculated in non-LTE regime was confirmed by ALMA observations; analytical calculation of the generalized plasma dispersion tensor for specific ring velocity distribution functions; detection & characterization of exoplanet atmospheres; radial velocity measurements to classify exoplanetary systems; development of a self-consistent hydrodynamic NLTE wind model code; the role of supergiant stars in the chemical abundances observed in stellar globular clusters; the discovery of the first bound remnant of a failed type I supernova with a metal-dominated atmosphere the interpretation which required new, specific spectroscopic tools; the full-fledged study of a super-Chandrasekhar double degenerate system consisting of two CO white dwarfs with similar masses & ages and one component being highly magnetized; the study of individual bolides leading to meteorite falls and of the physical properties & composition of meteoroids; the discovery that one particular meteoroid was, before its Earth collision, a temporary natural satellite of the Earth; the studies of the physical condition of *green-pea* galaxies; the numerical codes to model black hole (BH) accretion disks in active galactic nuclei and X-ray binaries that have been incorporated into XSPEC (the standard X-ray spectral package); the deduction of accretion regularities between stellar-sized and super-massive BHs; the behaviour of magnetic fields in rapidly moving plasma near rotating BHs; the geo-applications of high-resolution gravity field models that has led to the identification of a huge late-Paleozoic mass-extinction-class impact crater in Antarctica; a study of the effects of geophysical fluids & geomagnetism on the Earth's rotation.	
H1.5	**Contribution of the participation of the authors in large collaborations**
CAS/ASI personnel contributed to 3 (out of 10) instruments to ESA's *Solar Orbiter*, i.e. RPW (Radio and Plasma Waves), STIX (Spectrometer Telescope for Imaging X-rays), METIS (optical/UV coronal imager). As to ESO's ALMA radio/sub-mm telescope array, CAS/AI operates one node (out of 7) of the European ALMA Regional Centre and provides mm spectroscopy and solar physics expertise.	

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
CAS/ASI offers a broad range of outreach activities to bring current astronomy and astrophysics research to the general public. While astronomy might be more accessible to untrained audiences than (e.g.) theoretical physics, outreach activities at CAS/ASI are very impressive – i.e., schools‘ on-site visits, public lectures, radio & TV programs, book translations. Involvement in international ground-based and space-borne projects brought jobs and visibility to Czech companies.	
H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the institute´s activity on proper practice in society in the area of social sciences and humanities**
CAS/ASI is useful to society through: 1) monitoring and forecasting of space phenomena (space weather, geomagnetic activity, near-Earth objects, space debris) that have the potential of direct & hazardous impact on Earth; 2) collaboration with national aerospace industries to manufacture software and hardware for space missions; 3) development/maintenance of publicly accessible data bases and related software; and 4) public outreach and education.	
H2.3	**Relation to practice**
The main result with technological application potential obtained in 2015-2019 is the realization of 3 (out of 10) instruments for ESA‘s *Solar Orbiter* mission: RPW (Radio and Plasma Waves), STIX (Spectrometer Telescope for Imaging X-rays), METIS (optical/UV coronal imager).	
H2.4	**Participation in AV21 strategy**
CAS/ASI coordinates the inter-institutional *Space for Mankind* program of CAS‘s *AV21 Strategy* that includes 11 CAS institutes (which collaborate on 11 topics) and aims to strengthen cooperation between scientific and technical teams to develop innovative technologies for space research, and to further public awareness of space research. In particular X-ray astrophysics, solar physics, gravitational astronomy, and exoplanet research are based at the ASI. The *AV21 Strategy* supports Czech involvement in space science: *Solar Orbiter* (solar physics), JUICE (Jupiter’s icy moons), ATHENA and *e*XTP (X-ray astronomy), PLATO (exoplanets), LISA (gravitational waves).	
H2.5	**Cooperation with regions of the Czech Republic**
CAS/ASI partners with regional Czech institutions, foremost the Central Bohemian Region and the Region of Prague. With the former, the ASI has co-founded the Central Bohemian Innovation Centre that promotes technology transfer from academia to business. With the latter there is cooperation on operating the ASI premises and managing dark-sky areas.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the teams and the institute with similar international and national institutes

CAS/ASI is internationally respected, its standing is equal to famed similar-sized international institutions. Collaborations are ongoing with many European and some US institutions, with a busy schedule of mutual to-and-from visits.	
D1.2	**Scope and quality of international and national cooperation and the role of the institute in such cooperation; engagement in broad international cooperation**
CAS/ASI has strong national collaborations, mostly with Prague's Charles U. and Technical U., and with the Masaryk U. in Brno. As to international collaborations, it must be emphasized that the Czech Republic's membership in ESO (since 2007) and ESA (since 2008), i.e. the top European organizations in optical astronomy and space science, are effectively managed and carried out by CAS/ASI. In ALMA, a major international collaboration for radio/sub-mm astronomy, CAS/ASI developed the Solar ALMA Observing Mode. Other cooperations, focused on specific projects, link CAS/ASI with NASA and MIT in the USA, Shanghai Observatory and the Academy of Sciences in China, MPI-Astronomie (Heidelberg) and the Leibniz Institute for Astrophysics (Potsdam) in Germany, and several other institutes in Austria, Croatia, Germany, Japan, Korea, Poland, Serbia, Slovakia.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
CAS/ASI members have been quite active in organizing international conferences & workshops. Major highlights are the EU ALMA Regional Centre *All-Hands* meeting (2018), EWASS 2017 (European Week on Astronomy and Space Science), the 12th *International School & Symposium for Space Simulations* (2015), the *RadioSun-5* Workshop (2016), the AXRO (astronomical X-ray optics) and IBWS (high-energy astrophysics and supporting ground-based experiments) workshops (every year in 2015-2019), *Astroplate 2016* (digitization, preservation, use of photographic plates), *X and XUV Optics Synergy between Laboratory and Space* (2017). Furthermore, ASI staff are SOC members of international conferences and workshops.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**
Plans for the next period are clear and well-stated. They are mainly based on extrapolation of successful research lines in the previous period 2015-2019, but they are also poised for expansion towards upcoming projects (e.g. EST, CTA). Much care is devoted to collaborations with other European national (mostly German) and super-national (i.e., ESO and ESA) institutions.	
D2.2	**Assessment of the previous research objectives and their achievement**
Activities planned in 2015 mostly came to fruition according to expectations. An activity unforeseen back then, but which gave a powerful thrust to Team 1 activity, has been the involvement in solar research with ALMA. Overall, 2015-2019 activity exceeded expectations.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
Recommendations from past evaluation have been fully implemented where applicable. Recruiting qualified researchers from the Czech Republic and abroad through open calls has been intensified, which has led to a more balanced age distribution of the research staff. Teaching of college students has been expanded and is partly carried out at the ASI	

itself. Assessments of staff achievements, also finalized to pay raises, are carried out every year by committees composed of external and internal members. Scientific projects and related investment have been expanded to the effect that more postdoc positions and more part-time jobs (for, e.g., parental leave) are available now.

D2.4	Success in receiving grants

Doctoral grants from the Czech government have enhanced the ASI's PhD program. In addition, CAS/ASI members have been successful at obtaining Czech Science foundation grants and EU FP7 and Horizon 2020 grants. The many foreign-national postdocs working at CAS/ASI are financially supported by these grants.

D2.5	Adequacy of instrumental equipment

Instrumental equipment seems adequate to CAS/ASI needs. Mechanical workshops, also in charge of developing the equipment and instrumentation of the Perek 2m telescope, are efficient. The CAS/ASI computing facilities (hardware and software) are adequate, whereas more demanding calculations can be carried out on supercomputers abroad (e.g., SuperMUC in Garching, Germany).

D2.6	Effectiveness of management

The ASI management is effective to the best use of resources and in providing a thoughtful steering to the Institute's course of action for the coming term. Also, its affirmative action toward gender balance (also including part-time jobs for parental care) should be acknowledged. Also noteworthy is the transparency of its decision-making and quality assessment procedures.

D2.7	Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth

Scientists and engineers amount to ~2/3 of the CAS/ASI employees, the rest being administrative and technical personnel: this distribution seems adequate to run the ASI. Development strategies for 2020-2024 foresee continuation of current successful activities; however, in astronomy it is physiological that new phenomena may appear and warrant instant attention: in this case CAS/ASI has sufficient numbers of qualified people in each Team to tackle possible new challenges. At this point it should be stressed that fragmentation of research topics might be considered a partial risk, while on the other hand diversification has its clear advantages in the fast-changing environment of the current science. Strategies to attract best scientists have been successfully implemented in 2015-2019, offering financially competitive postdoc positions (thanks mostly to grants) to Czech nationals abroad and to foreign nationals as well. The age distribution peaks at 35-45 for the academic staff (scientists and engineers: 99 persons) and at 35-50 for all (155) employees. Employees are encouraged to systematic professional growth also through yearly assessments of their accomplishments. In the recruitment of new personnel, external expert assessment and face-to-face interviews are encouraged; members of selection panels should be adequately trained.

D2.8	Creating work-life balance conditions, assessment of approach towards possible gender issues

Women currently constitute ~40% of the personnel, with an appreciable increase in 2015-2019: though better than in most Czech institutions, gender balance – at all levels of staff – should still improve. It is important to note that the gender diversity in the postdoc, permanent researcher, and leadership is lower and varies significantly across teams. Comprehensive institution-wide monitoring of the gender balance and recruitment processes according to best practices should be developed.

D2.9	Relation of the institute with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.
N.A.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level
Collaboration with major Czech universities (e.g. Prague, Brno, Opava), as well as foreign institutions, allows CAS/ASI staff to teach specific courses and seminars and to supervise PhD theses – so helping students to reach their own scientific maturity.	
D3.2	**Effectiveness of joint research centres**
The *Albert Einstein Centre for Gravitation & Astrophysics*, a recent partnership between CAS/ASI and Prague‘s Charles U. and Opava‘s Silesian U., has proven very successful in terms of research (several papers published), education (17 PhD theses successfully defended), and organization of scientific events and conferences.	
D3.3	**Success rate in supervision of PhD students**
12 PhD theses supervised in the 2015-2019 term.	
D3.4	**Participation of PhD students in the outputs**
PhD students regularly participate in research activities and co-author ensuing papers.	
D3.5	**Participation of the institute in master or bachelor studies**
26 Bachelor and 31 Master theses were supervised in the 2015-2019 term.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
CAS/ASI participates in undergraduate teaching of Astronomy, Astrophysics, and Plasma Physics at the Charles U. in Prague. Students from other Czech and Slovak universities are supervised by CAS/ASI personnel. Also, CAS/ASI provides PhD education in synergy with Czech universities.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
The outreach activity is carried out extensively and with competence. The newly introduced full-time position of a public-relation manager ensures a continuous level of high-profile visibility. Regular press releases and cooperation with national press and TV/radio ensure an ongoing flow of information on the CAS/ASI activity to society (i.e., taxpayers). Open days (with ~10000 visitors in 2015-2019) and guided tours to the ASI‘s premises and historical sites (e.g. Ondrejov) ensure children as well as any interested citizen to appreciate science, the ASI’s activity, and the country’s national heritage of astronomical infrastructure. An important item is the collaboration with national and international	

institutions to preserve the dark night sky – a part of the world's immaterial heritage – against light pollution.	
D4.2	**Publishing activities and its quality**
Published outreach material is available electronically. The nicely maintained ASI section of the CAS website is devoted to the general public and to young children. The AI fb page is the most watched within CAS.	
D4.3	**Participation in professional organisations in the area of research and development**
CAS/ASI participates in professional organizations such as universities, schools and the Czech Ministry of Education in the area of research and development with the aim to provide continuing education to school teachers and approach young students to research.	

Other comments of the commission:
None.

Part B: Evaluation of teams

1. Department of Solar Physics - Team 1

Strengths:

Research focused on sharply delineated topics, that favours depth & visibility in such topics; good mix between theory/modelling and data analysis; strong involvement in international collaborations (ALMA, Solar Orbiter, EST); markedly international research environment; good gender & age balance; collaborative & friendly intra-team atmosphere.

Weaknesses:

Uncertain financial situation, with most young researchers supported on soft money; technical personnel are understaffed; few Physics students as a pool of prospective CAS/ASI staff and team members.

Opportunities:

The strong involvement in international collaborations (ALMA, Solar Orbiter, EST) calls for enhanced support of the team.

Threats:

Some groups, even of international relevance for the service they provide, are of sub-critical size and potentially at risk of disappearance if just 1-2 people leave.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
Results presented in Phase I-selected outputs are published in well-known, peer-reviewed journals (*Astrophysical Journal*, *Astronomy & Astrophysics*, *Solar Physics*).	
H1.2	**Contribution of workers on the outputs reached**
The team‘s scientists are first or corresponding authors of most of the papers.	
H1.3	**Quality of all outputs and results**
The standing of journals where the team‘s results are published ensures the latter‘s (very) high quality.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
A few highlights of valuable findings are: the 3D nature of magnetic reconnection; the Kappa distribution of particle energies is ubiquitous in the solar atmosphere as a manifestation of non-equilibrium physics; the umbra/penumbra border line in sunspots may highlight a sharp transition between two zones of magnetic convection regime; the fine structure of prominences calculated in the non-LTE regime was confirmed by ALMA observations; analytical calculation of the generalized plasma dispersion tensor for specific ring velocity distribution functions; major solar radio burst registered by Team1’s spectrograph identified as a source of Global Navigation Satellite System (GNSS) outage.	

H1.5	Contribution of the participation of the authors in large collaborations
Team1 personnel contributed to 3 (out of 10) instruments to ESA's *Solar Orbiter*, i.e. RPW, STIX, METIS. Solar ALMA observing mode successfully commissioned: Team1 is a leader of European participation in ALMA solar studies. The team also participates in the preparatory phase of EST (the European Solar Telescope)	

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
Based on the team's expertise & results, team members are involved in: teaching activities at Czech & Slovak universities (in Prague, Brno, Bratislava) lectures, seminars, and bachelor, master, PhD student supervision; management of research-community life as board members of solar Physics sections of (e.g.) COSPAR, EPS; and public-relation activities, e.g. public lectures, media interviews, public observations, guided tours.	
H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**
The team is useful to society through monitoring & forecasting of solar phenomena (space weather, risk assessment of major solar events and evaluation of long-term cumulative impact on power grids, and direct impact of solar events on the GNSS.	
H2.3	**Relation to practice**
See H2.2.	
H2.4	**Participation in AV21 strategy**
The *Solar Orbiter* involvement of the team is supported by the *AV21 Strategy*.	
H2.5	**Cooperation with regions of the Czech Republic**
The team cooperates with regional Czech institutions under the umbrella of CAS/ASI – see H1.5	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
The team leads European participation in ALMA solar studies. The ALMA node shows team standing to be high by international standards.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
The team has strong national collaborations, with the Solar-Physics–oriented groups of Czech universities (e.g. Prague, Brno, South Bohemia), and with regional public observatories and well-equipped amateur astronomers to monitor solar (sunspot) activity. It also has maintained & expanded international cooperations with universities and research	

institutions in Austria, Belgium, Brazil, China, France, Germany, Italy, Japan, Norway, Poland, Spain, Russia, Slovakia, Switzerland, UK, USA.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The team organized two major conferences in 2015-2019: the 12th *International School & Symposium for Space Simulations* (2015), and the *RadioSun-5* Workshop (2016).	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**
Plans for the next period are clear and well-stated. They are mainly based on extrapolation of successful research lines developed in the previous period 2015-2019.	
D2.2	**Assessment of the previous research objectives and their achievement**
The team‘s activities planned in 2015 developed as expected. The then-unforeseen involvement in ALMA gave a strong thrust to the team activity. Overall, the 2015-2019 activity exceeded expectations.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
No explicit recommendation was given in the previous evaluation report. However, a desirable bigger support to Team1’s involvement in top international infrastructure was suggested. So the team successfully placed its activity under the Czech government’s Large Research Infrastructure programme. In particular, LRI status was acquired by Team1’s participation in ALMA (2015, extended to 2022) and in EST (the upcoming European Solar Telescope; 2019).	
D2.4	**Success in receiving grants**
The team has been successful as (co)recipient of grants by which PhD students and participation at conferences are supported.	
D2.5	**Adequacy of instrumental equipment**
In-house infrastructure is currently adequate. A set of imaging telescopes for regular monitoring of sunspot activity are ok for Solar Patrol Service use. The HSFA2 multi-channel spectrograph to observe solar flares and prominences benefits from a recent upgrade of the of the data acquisition system. The 4-antenna system observing the Sun‘s 0.8-4.5 GHz spectral flux has been upgraded with new software. High-performance computer clusters are available for heavy simulations and ALMA data processing.	
D2.6	**Effectiveness of management**
The team management is subordinate to the CAS/ASI management. Weekly seminars (and/or discussions on recent papers or hot topics) help the closeness and coherence of the team‘s working groups.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The team is composed of 31 scientists & engineers, and 6 technical & administrative personnel: this distribution seems adequate to run Team1. Development strategies for 2020-2024 foresee continuation of current successful activities. However, experience in this very evaluation period has shown that unexpected developments may occur.	

Recruitment strategies, subordinated to CAS/ASI rules, have been successful in balancing age and gender distribution. The age distribution peaks at early/mid-career (ages 35-40). As for all CAS/ASI employees, Team1 members are encouraged to systematic professional growth also through yearly assessments of their accomplishments.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
Women constitute 30% of personnel.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**
N.A.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**
Scope of cooperation with universities is to attract students to work & write theses on Solar-Physics projects proposed by Team1 members. This is very important also in consideration of the generally low number of Physics students in Czech universities.	
D3.2	**Effectiveness of joint research centres**
A joint research project with the Centre for Astrophysics of Berlin's Technical University was approved in late 2019 and was due to start in 2020.	
D3.3	**Success rate in supervision of PhD students**
3 PhD theses were successfully defended in 2015-2019 (involving 9 supervisors plus 1 consultant).	
D3.4	**Participation of PhD students in the outputs**
The team‘s PhD students regularly participate in research activities and co-author ensuing papers.	
D3.5	**Participation of the team in master or bachelor studies**
The team has provided 6 Bachelor-thesis supervisors, and 5 Master thesis supervisors (plus 1 consultant).	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The team‘s staff help teaching specialized courses at Prague, Brno and Bratislava (SK) Universities.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
Face-to-face hand-on activities for the general public are carried out at Ondrejov Observatory during the *Days of Open Doors*. Team members visit schools of all levels to	

introduce astronomy to young students and give public lectures in cultural & educational facilities. The *Vacations with the Sun* summer school is organized every year for high-school students.	
D4.2	**Publishing activities and its quality**
Published outreach material is electronic (fb, CAS/ASI website, media interviews) and printed (popularization magazine articles and one book).	
D4.3	**Participation in professional organisations in the area of research and development**
Under the umbrella of CAS/ASI, the team participates at universities, schools and the Czech Ministry of Education in the area of research & development in order to provide continuing education to school teachers and initial astronomical education to young students.	

Other comments of the commission:
None.

2. Department of Stellar Physics - Team 2

Strengths:
A broad range of theoretical topics of stellar-atmosphere physics, and direct access to instrumentation are obvious strengths.

Weaknesses:
3 computational assistants left but are hard to replace because information technology specialists get better-paid jobs in industry. The High-Energy Astrophysics group is severely understaffed after 3 (out of 7) members left (in 2019).

Opportunities:
Exoplanet research, a timely new entry among more traditional team activities, is in blooming state and holds the possibility of developing into a highly successful activity for the team.

Threats:
Exoplanet research, although a strategic decision in 2017, is primarily grant-based now: this may turn into a threat to the team unless suitable institutional support is granted.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
Results presented in Phase I-selected outputs are published in well-known, peer-reviewed journals (*Astrophysical Journal*, *Astronomical Journal*, *Astronomy & Astrophysics*, *Monthly Notices of the Royal Astronomical Society, Science*).	
H1.2	**Contribution of workers on the outputs reached**
Team2 scientists are first or corresponding authors of most of the papers.	
H1.3	**Quality of all outputs and results**
The standing of journals where the team‘s results are published ensures the latter‘s (very) high quality.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
Highlights of valuable findings are: detection and characterization of exoplanet atmospheres; radial velocity measurements to classify exoplanetary systems; development of a self-consistent hydrodynamic NLTE wind model code; the role of supergiant stars in the chemical abundances observed in stellar globular clusters; the discovery of the first bound remnant of a failed Type I supernova with a metal-dominated atmosphere the interpretation of which required new, specific spectroscopic tools; the full-fledged study of a super-Chandrasekhar double degenerate system consisting of two CO white dwarfs with similar masses & ages and one component being highly magnetized.	
H1.5	**Contribution of the participation of the authors in large collaborations**
The team‘s personnel contributed to several large collaborations: TESS (NASA’s Transiting Exoplanet Survey Satellite), GAIA (ESA’s astrometric satellite) Coordination Unit 7, CTA (the gamma-ray Cherenkov Telescope Array), BOOTES (the worldwide robotic telescope network) , IVOA (the international Virtual Observatory alliance), and PLATO (the PLAnetary Transit & Oscillations of stars space mission).	

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
Based on the team‘s expertise and results, team members are involved in: teaching activities at Czech universities (in Prague, Brno) lectures, seminars, and bachelor, master, PhD student supervision; management of research-community life as board/panel members at ESO, NASA, ESA, as editorial board members of journals, and instrument-committee members; and public-relation activities, e.g. public lectures, media interviews, and public observations.	
H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**
One aspect of the team’s activity that is potentially useful to society at large is the development of technology (in collaboration with the Information Technology Faculty of the Czech Technical University) for handling big data cubes and deep learning. Although currently specialized to astronomical data, this project has a big potential for technological transfer.	
H2.3	**Relation to practice**
N.A.	
H2.4	**Participation in AV21 strategy**
N.A.	
H2.5	**Cooperation with regions of the Czech Republic**
N.A.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	Comparison of the team with similar international and national institutes
Overall, the team is superior to similar Czech teams and, actually, compares with similar international teams. In detail, the High-Energy Astrophysics group is severely understaffed.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
The team has strong national collaborations, with similarly oriented groups of Czech universities (e.g. Prague, Brno). It also has international cooperations with universities and research institutions in Argentina, Belgium, Brazil, Chile, Estonia, Germany, Poland, Serbia, UK.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Team members have been active in organizing international conferences and workshops. Major highlights are: EWASS 2017 (European Week on Astronomy and Space Science), the AXRO (astronomical X-ray optics) and IBWS (high-energy astrophysics and supporting ground-based experiments) workshops (every year in 2015-2019), *Astroplate 2016* (digitization, preservation, use of photographic plates), *X and XUV Optics Synergy between*	

Laboratory and Space (2017). Furthermore, Team2 members are SOC members of international conferences & workshops.

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**
Plans for the next period are clear and well-stated. They are mainly based on extrapolation of successful research lines developed in the previous period 2015-2019.	
D2.2	**Assessment of the previous research objectives and their achievement**
The team‘s activities planned in 2015 developed as expected. The newly established group on exoplanets gave a strong thrust to Team2 activity. 2015-2019 activity exceeded expectations.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
Steps were taken to implement the past evaluation‘s recommendation to optimize use of the Perek-2m-telescope. A major step was replacing the mirror-based optical path with an optical fiber. This improved the telescope’s capability in spectroscopy and expanded it to photometry. Also, an echelle spectrograph is being used alongside the Coudé slit one.	
D2.4	**Success in receiving grants**
The team has been successful in receiving grants to fund postdocs.	
D2.5	**Adequacy of instrumental equipment**
Concerning in-house instrumentation, major refurbishment has brought the Perek 2m telescope to state-of-art capability. It is used for scientific observations (alongside the BART/SBT robotic telescope) and student training.	
D2.6	**Effectiveness of management**
The team management is subordinate to the CAS/ASI management. The establishment (in 2017) of the highly successful Extrasolar Planet Research (a.k.a.Exoplanets) working group is a testimony to the effectiveness of the team‘s management.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The team is composed of 31 scientists and engineers, and 12 technical & administrative personnel. This distribution seems adequate to run the team. Development strategies for 2020-2024 foresee continuation of current successful activities; however, experience in this very evaluation period has shown that unexpected developments may occur. Recruitment strategies, subordinated to CAS/ASI rules, have been successful in balancing age and gender distribution. The age distribution peaks at early/mid-career (ages 35-45). As for all CAS/ASI employees, Team2 members are encouraged to systematic professional growth also through yearly assessments of their accomplishments.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
Women constitute 38% of personnel.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**

N.A.

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level
The scope of cooperation with universities is to attract students to work and write theses on projects proposed by Team2 members. This is very important also in consideration of the generally low number of Physics students in Czech universities.	
D3.2	**Effectiveness of joint research centres**
N.A.	
D3.3	**Success rate in supervision of PhD students**
2 PhD theses were successfully defended in 2015-2019 (involving 7 supervisors and 8 consultants).	
D3.4	**Participation of PhD students in the outputs**
PhD students regularly participate in research activities and co-author ensuing papers.	
D3.5	**Participation of the team in master or bachelor studies**
The team has provided 8 Bachelor-thesis supervisors (plus 6 consultants), and 6 Master thesis supervisors (plus 4 consultant).	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
Team members help teaching specialized courses at universities in Prague, Brno, Wroclaw (PL), and Akdeniz and Erciyes (TR).	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
Activities for the general public are carried out at Ondrejov Observatory during the Open *Days*. Special public celebrations were held in 2017 to celebrate the 50th anniversary of the 2m Perek telescope. Team members visit schools of all levels to introduce astronomy to young students and give public lectures in cultural & educational facilities.	
D4.2	**Publishing activities and its quality**
Published outreach material is electronic (fb, CAS/ASI website, media interviews) and printed (popularization magazine articles).	
D4.3	**Participation in professional organisations in the area of research and development**
Under the umbrella of CAS/ASI, the team participates at universities, schools and the Czech Ministry of Education in the area of research & development in order to provide continuing education to school teachers and initial astronomical education to young students.	

Other comments of the commission:
None.

3. Department of Interplanetary Matter - Team 3

Strengths:
Internationally leading research in meteoroids and asteroids; significant exposure in media; outstanding facility in the Czech fireball network.

Weaknesses:
Lack of gender diversity amongst researchers; sufficient training of junior researchers.

Opportunities:
The team's facility provides the basis for agile adaptions to fireball events; the team's international partnerships are a solid platform to retain leadership in the field.

Threats:
Continued recruitment of PhD students and junior researchers; long-term financial support for the group.

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
The team submitted very strong outputs and demonstrated quality and productivity at a high level. In both metrices the team scored well above the average.	
H1.2	**Contribution of workers on the outputs reached**
The majority of the papers were led/co-led by team members or team members contributed significantly to the design of the studies and interpretation.	
H1.3	**Quality of all outputs and results**
The team's outputs are in general of high quality and have been published in the relevant field-specific journals with high impact factors.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The team had several high-profile research results in the evaluation period that were published in high-impact journals. Amongst the highlights were the characterisation of the geometry of 1I/Oumuamua, the first interstellar object passing through our solar system and the discovery of a new branch of the Taurid meteoroid stream as a source of potentially hazardous objects.	
H1.5	**Contribution of the participation of the authors in large collaborations**
The team primarily published in smaller to mid-sized collaborations where they often took leadership/coordination roles.	

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission
The team addresses questions that are interesting to the general public: asteroids as a potential threat to life on earth, origin of the solar system, fireballs, etc. This has the	

potential to grab the interest of the next generation for astronomy and STEM in general. Given this background, the committee thinks that outreach activities could be increased and better targeted. This may involve supplementing TV appearances, having an unspecified (or rather „willing“) audience, with more face-to-face interaction in/with schools including diverse participants (gender and social background).	
H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**
N/A	
H2.3	**Relation to practice**
N/A	
H2.4	**Participation in AV21 strategy**
Not addressed.	
H2.5	**Cooperation with regions of the Czech Republic**
Not addressed.	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	**Comparison of the team with similar international and national institutes**
The team works on small research fields (meteoroids, asteroids) as compared to others in astronomy with the usual high degree of internationalisation. Within these fields, the team is very well recognised and has a world-leading facility in the Fireball Network that supported part of the high-quality outputs.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
The team is very well connected internationally and leads or coordinates research on topics of interest in the research fields.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
Team members engage with and contribute to activities of the international science community as expected.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**
The research strategy for the next years that has been laid out during the online visit on the asteroid topic was reasonable, but considered a bit reactive for the meteoroid group. While the commission agrees that individual big events are not predictable, scientific questions that can be answered by studying recurrent meteoroid streams or sporadic events should be formulated and made an integral part of the forward vision for the group to continue driving research directions in the field.	

D2.2	Assessment of the previous research objectives and their achievement
The team has delivered on the major elements of the past research strategy.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
N/A	
D2.4	**Success in receiving grants**
The team secured adequate funding for the infrastructure and personnel.	
D2.5	**Adequacy of instrumental equipment**
The team operates a world-class fireball network.	
D2.6	**Effectiveness of management**
The team seems well managed judging by the quality of research outputs.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
There are some concerns regarding recruitment, mentoring, and retaining a diverse group of researchers. At the time of the evaluation, scientists were exclusively men. While recruitment of women researchers has been mentioned as challenging due to a small fraction of women graduates in physics, the team should aspire to at least match that level of participation (20-25%) and develop a proactive plan for future hires of women postdocs and staff researchers. In this effort, it is recommended that the team seek support from the institute and/or other departments that are more successful in this area to improve their recruitment procedures and become more proactive in attracting applications from qualified women. The report also mentions a perceived lack of efficiency of more junior members of the team as compared to senior researchers. Considering the natural gradient in experience this is not unexpected. However, it is recommended that the team establish a mentoring programme to help the professional development of junior team members.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The team follows the institute's policies. For gender related issues, see D2.7 above.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**
Not addressed.	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	Scope of cooperation with universities on national and international level
The team cooperates effectively with national and international universities.	
D3.2	**Effectiveness of joint research centres**
N/A	

D3.3	Success rate in supervision of PhD students
The team has graduated one PhD student in the evaluation period, but it is not known if there were any unsuccessful candidates.	
D3.4	**Participation of PhD students in the outputs**
The team has few PhD students as compared to other teams, even if normalised by the number of FTE and it is mentioned that recruitment is difficult.	
D3.5	**Participation of the team in master or bachelor studies**
The team has supervised one master student to completion, which is low even if normalised by the number of FTE.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
As per the team's report, they did not engage in university teaching. This is considered a weakness and may be at least part of the reason why few bachelor/master/PhD students work in the team, having long-term effects on its sustainability. It is recommended that the team starts engaging with teaching at suitable Czech universities to improve the appeal to students.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	Sufficiency of media strategy and activities in the area of research popularisation
The team is very present in national media, including TV shows.	
D4.2	**Publishing activities and its quality**
The team released several press releases related to their research outputs.	
D4.3	**Participation in professional organisations in the area of research and development**
Researchers of the team are members of the IAU.	

Other comments of the commission:

None.

4. Department of Galaxies and Planetary Systems - Team 4

Strengths:
Internationally leading in a range of topics in extragalactic science and geodesy; leading involvement in major international facilities (e.g. ESO, ESA, ALMA); co-leadership of Czech ALMA node; membership in international collaborations and projects.

Weaknesses:
Strong dependence on grant funding.

Opportunities:
Cooperation on facilities provide the basis for continued research success.

Threats:
Continued expansion of involvement in research facilities may stretch resources; heavy dependence on grants; retention of researchers with required expertise (e.g. polarisation).

Main criterion: 1. Quality of results (H1.1-H1.5)

H1.1	Quality of selected outputs of Phase I
The team submitted strong outputs and demonstrated quality and productivity at a high level. In both metrices the team scored above the average.	
H1.2	**Contribution of workers on the outputs reached**
The majority of the papers were led/co-led by team members or team members contributed significantly to the design of the studies and interpretation the results.	
H1.3	**Quality of all outputs and results**
The team's outputs are in general of high quality and have been published in the relevant field-specific journals with high impact factors.	
H1.4	**The most valuable discoveries and findings in the fields, their importance for the field**
The team has a very beneficial diversity of extragalactic topics in both the observational as well as theoretical domain. Observational highlights concern work on ram pressure stripping of gas in galaxies, the physics and dynamics of the DSO in the Galactic Centre, as well as studies of polarisation in AGN. On the theoretical side, simulations helped pinning down the origin of multiple stellar populations in globular clusters. The geodesy team used their expertise to confirm the largest impact crater on earth underneath the Antarctic ice shelf.	
H1.5	**Contribution of the participation of the authors in large collaborations**
Most of the work by the authors is done in smaller teams, but they are also well integrated in larger collaborations, e.g. the ALMA node, SILCC, StrongGravity, and Swarm DISC.	

Main criterion: 2. Societal relevance (H2.1-H2.5)

H2.1	Societal relevance of outputs and results pursuant to CAS and institute mission

The team undertook an impressive public outreach programme with a good number of face-to-face interactions and TV appearances.	
H2.2	**System functionality for knowledge transfer into practise, its usefulness for society. The impact of the team´s activity on proper practice in society in the area of social sciences and humanities**
N/A	
H2.3	**Relation to practice**
N/A	
H2.4	**Participation in AV21 strategy**
The team participates in the AV21 strategy through the ALMA node and the “Space for Mankind” topic via their engagement with ESA missions.	
H2.5	**Cooperation with regions of the Czech Republic**
N/A	

Further criterion: 1. Position in international and national context (D1.1-D1.3)

D1.1	**Comparison of the team with similar international and national institutes**
The team is well integrated into the international communities and has a strong track record of science at the forefront of the fields they are studying. The work in extragalactic astrophysics has a large international audience and the team is competitive in this environment.	
D1.2	**Scope and quality of international and national cooperation and the role of the team in such cooperation; engagement in broad international cooperation**
The ALMA node is a true highlight, provides significant international exposure, and gives an edge to Czech researchers to use this major facility. The team’s involvement with ESA missions is similarly strong and keeps the researchers engaged with the top space facilities in high-energy astrophysics.	
D1.3	**Participation of the workers in scientific community activities (organizing of conferences and workshops, invited lectures, awards)**
The researchers are regularly invited to give talks at conferences and other institutions and have organised topical conferences themselves, including sessions at EWASS 2017 in Prague.	

Further criterion: 2. Vitality, sustainability and strategy (D2.1-D2.9)

D2.1	**Direction in line with the perspective of the planned research directions**
The goals of the next 5 years are well formulated. The only minor concern would be that bulk of the polarization research in the evaluation period has been led by a researcher who left the team (Marin) and needs replacement. In addition, the planned extension into LOFAR should be weighed against current commitments and financial constraints to avoid overstretching resources.	

D2.2	**Assessment of the previous research objectives and their achievement**
The team fulfilled the core of its research objectives from the last assessment.	
D2.3	**Assessment of implementation of recommendations from past evaluation**
N/A	
D2.4	**Success in receiving grants**
The team received a number of grants that supported an about constant researcher workforce over the evaluation period.	
D2.5	**Adequacy of instrumental equipment**
All equipment is of suitable standard.	
D2.6	**Effectiveness of management**
The team appears well managed.	
D2.7	**Assessment of professional structure, development strategy and the strategy of keeping best scientists, age structure, career and qualification growth**
The team has a healthy age and gender structure and includes a good number of international researchers.	
D2.8	**Creating work-life balance conditions, assessment of approach towards possible gender issues**
The team showed awareness of gender issues and followed institute's policies.	
D2.9	**Relation of the team with regard to the integration, development and sustainability of the research centre funded by the National Programme of Sustainability II.**
N/A	

Further criterion: 3. Cooperation with universities and participation in education (D3.1-D3.6)

D3.1	**Scope of cooperation with universities on national and international level**
The team has long-standing collaboration with several international universities.	
D3.2	**Effectiveness of joint research centres**
N/A	
D3.3	**Success rate in supervision of PhD students**
During the evaluation period, the team supervised 6 students to completion. A success rate was not available.	
D3.4	**Participation of PhD students in the outputs**
The 6 students contributed to/led 9 outputs.	
D3.5	**Participation of the team in master or bachelor studies**

The team supervised 7 bachelor and 10 master students to completion.	
D3.6	**Assessment of cooperation intensity with universities in the form of teaching**
The team contributes significantly to university teaching, having taught several lectures/seminars at the Master level.	

Further criterion: 4. Outreach activities (D4.1-D4.3)

D4.1	**Sufficiency of media strategy and activities in the area of research popularisation**
Researchers publicised their results in various media, including press and TV.	
D4.2	**Publishing activities and its quality**
Press releases were not mentioned in the report.	
D4.3	**Participation in professional organisations in the area of research and development**
The team engages with professional organisations and participated in a number of committees of large research organisations (e.g. ESO).	

Other comments of the commission:
None.

Final report was elaborated by:

Commission 2 - Physical sciences
Evaluated teams No.: 1, 2, 3, 4

Commission Chair: Prof. Martin Stutzmann
Commission Deputy Chair: Karol Flachbart
Commission Members:

- Wojtek Bock
- Ingo Dierking
- Niall English
- Stefano Forte
- Peter Grabmayr
- Sebastian Hoenig
- Thomas Kuehl
- Massimo Persic
- Juergen Reif
- Jochen Schieck
- Claus Schneider