Evaluation of the Research and Professional Activity of the Institutes of the Czech Academy of Sciences (CAS) for the period 2010–2014

Final Report on the Evaluation of the Institute

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

Fields, in which the Institute registered its teams:

Physical sciences

Observer representing the Academy Council of the CAS: Tomáš Kruml
Observer representing the Institute: Petr Heinzel, substitute observer Jiří Borovička

Commission No. 3: Physical sciences
Chair: Prof. John Dainton

Date(s) of the visit of the Institute: October 15 - October 23, 2015
Programme of the visit of the Institute: see attached Minutes from the visit

Evaluated research teams:
No. 1 - Department of Solar Physics; No. 2 - Department of Stellar Physics; No. 3 - Department of Interplanetary Matter; No. 4 - Department of Galaxies and Planetary Systems

A. Evaluation of the Institute as a whole

1. Introduction

The Astronomical Institute of the Czech Academy of Sciences (AI CAS) is the largest professional institution in the country which focuses on astronomy and astrophysics. That said, it is a natural barycenter of this research in the Czech Republic, holding most of the key traditional fields that are being developed until now. It is a highly active place of an up-to-date research with a lot of international, as well as national, collaboration. At the national level its partners are mainly the major universities (Prague, Brno and Opava), where employees of AI CAS help teaching specialized courses and from where most of the PhD students trained at AI CAS come from. The institute participates at a number of world- and European-level large ground-based and space-based projects (many coordinated by ESO or ESA). In several such cases, opportunity for participation of small Czech high-tech companies has been created.

2. Strengths and Opportunities

Decades of research, combined with new observational possibilities, theoretical approaches and ideas, constitute the major strength of AI CAS. There are several fields, such as solar astronomy of active phenomena, stellar astronomy of early-type classes and/or meteoritic astronomy, where AI CAS conducts research since 1950s and in which it has long reached world recognition. Nevertheless, new topics and opportunities, such as in galactic astronomy, high-energy astrophysics and/or relativistic astrophysics, are being skilfully introduced. More than 60% of academic staff at AI CAS is younger than 45 years which is certainly very promising for the future. Involvement at large ESO and ESA projects will allow this generation of young astronomers to participate on cutting-edge research worldwide.

3. Weaknesses and Threats

There are no major weaknesses to be reported. Smaller issues are (i) ability of the institute to keep young, promising researchers and to offer them career-long positions, and (ii) to optimize results/cost ratio for large, on-site instruments. As to (i), efforts should be made to use as much as possible both national and European grant possibilities, and obtain institutional support from the Academy. As to (ii), which applies mainly to the 2-m telescope operations, perhaps a dedicated expert committee could advice the best strategy.

4. Recommendations

There are no specific recommendations on AI CAS, except for a praise of its wide support from the central Academy institutions. AI CAS, being very active and internationally renowned institution, delivers a world-quality research.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

Several teams at AI CAS are world-leading in their specific expertise. The overall quality of science results is very high and internationally respected. It is not surprising then that teams at AI CAS are invited to participate at international-scale large projects, whose results will form a skeleton of major astronomy results in the next decade.

Declaration on the involvement of students in research

In collaboration with major universities in the Czech Republic, as well as several foreign institutions, researchers at AI CAS supervise a large number of PhD theses, helping to bring these students toward the leading science level. They also widely participate on teaching specialized courses and seminars at the universities in Prague, Brno and Opava.

Declaration on societal relevance

AI CAS offers a large palette of outreach activities through which it brings current research in astronomy and astrophysics to general public. While popularization of astronomy might be fundamentally easier than, say, solid state physics, the activities of AI CAS are still very impressive starting from school and on-site visits, public lectures, radio and TV programmes up to book translations. Involvement in some of the international ground-based or space-based projects already brought opportunity to small Czech industrial companies to participate and gain their visibility.

Declaration on the position in the international and national context

AI CAS is respected on international level and a barycenter of the Czech professional research in astronomy and astrophysics. A lot of collaboration has been established with especially European institutions, with many AI CAS members visiting abroad and many foreign researchers visiting the institute.

Declaration on the vitality and sustainability

The employees´ age structure is very promising for future of the astronomy in the Czech Republic; more than 60% of academic staff members are younger than 45 years. So far AI CAS has been very successful in obtaining grant money that allowed an impressive growth over the evaluated period of 2010-2014. Efforts should be made to keep this trend, or at least not to revert it.

Declaration on the strategy and plans for the future

The strategy and plans for the future period are clear and well-stated. They are mainly based on extrapolation of successful research in the previous period 2010-2014, but they also forsee expansion where new projects will start to be operational or effectively developing. A great deal of care is paid on collaboration with other European institutions within ESO and ESA projects.

B. Evaluation of the individual teams

Evaluation of the Team No. 1: Department of Solar Physics

1. Introduction

The Solar physics group performs a complex analysis of energetic processes related to active regions on the solar surface as well as accompanying heliospheric phenomena. Its research results are internationally renowned as reflected by numerous collaborations in Europe and beyond. They comprise both programmes on a level of individual researchers, and also participation of smaller teams on ground-based and space-based projects. The major achievement though is participation on the ESO-coordinated ALMA project, for which the team holds Czech ARC node (one of seven European institutions of this kind). Importantly, this is the only ALMA node especially devoted to solar research.

2. Strengths and Opportunities

Except for the issues of the solar structure, research of the group covers the most interesting aspects of the solar physics, including analysis of how the solar-induced perturbations propagate through the interplanetary medium and reach eventually our planet ("solar weather aspects"). While each team in the group covers different aspects and may work in an autonomous way, they also have common projects, where their expertise overlaps. Fruitfully, members of the group combine both theoretical and observational skills. The theory part is represented principally by analysis of (i) radiative transfer in complex geometries and/or rapidly evolving structures, and (ii) processes of magnetic reconnections, and associated particle acceleration, which drive solar flares. In both aspects the team members are forefront experts. On the observational side, the group operates on-site multichannel spectrograph, a unique instrument that has been developed and improved for decades, as well as a smaller suite of radio-telescopes and solar patrol facility. Very important is the team's participation on numerous ground-based (ALMA, GREGOR, EST) and space-based projects (Solar orbiter, JUICE). These will certainly bring cutting-edge results in the next decade(s) and boost our knowledge of physics processes on the Sun. The current participation of the group members in these projects already now defines its internationally important future status.

3. Weaknesses and Threats

There are no manifest weaknesses in the group and in its outputs during the evaluation period. If any weakness for the future had to be mentioned, one may note the unusual breadth of international collaborations as well as the local instrumentation run by the group. Apparently, as of now demands of these involvements were such that the manpower of the group was sufficient. If, instead, in the future the necessary involvement in international projects increases (as it may, because they will move from preparatory phase to full operations and data analysis), a decision might be needed which of the activities prioritize.

4. Recommendations

While the solar physics programme at the Institute builds on a long-term tradition, impressive steps and decisions have been done in the past decade to keep its activity at the very forefront of the world-class research. This is mainly revealed by a participation in the above-mentioned international projects that will define status of the solar studies in the forthcoming decade. Therefore the group should be supported as strongly as possible.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The group produces an impressive amount of publications in highly ranked international journals, both general in astronomy and specialized in solar physics. Each team within the group (e.g., solar flare and prominences physics, dynamics of the solar atmosphere, and heliosphere and space weather) is somewhat autonomous and highly active. Basically all publications evaluated in the phase I are either exclusively written or lead by members of the team in an international collaboration. Clearly the contribution of the team members is decisive.

Declaration on the involvement of students in research

Members of the group conduct specialized courses at several universities in the Czech Republic and abroad (e.g., Wroclaw in Poland). Number of master- and PhD-level students supervised by the senior group members is high (there were 4 Bc, 5 Master and 5 PhD theses lead by the team members of which 3 defended in the time interval 2010-2014). It certainly reflects on a fair proportion of young researchers in the team.

Declaration on societal relevance

The solar physics and space weather issues are attractive enough to be easily communicated to general public. Indeed, the group participates in many outreach activities, public lectures and on-site visits. Involvement in ground- and space-projects, such as Solar probe, brings opportunities for small IT or high-tech companies in the Czech Republic.

Declaration on the position in the international and national context

The group is highly praised in the international context. During the evaluated period there were six workshops and conferences organized and co-organized by the team members, which certainly helped to even increase the group's international visibility. On the national level it does not have a competitor as far as the solar research is concerned.

Declaration on the vitality and sustainability

Each of the teams and the group as such are well managed. The funding is balanced between the institutional contribution and grant projects. The high-level of science results allows an easy flow of the latter, both from national science foundation and European level foundation. The group apparently does not have a problem to attract young researchers, whose funding could – if necessary – be assured by money spent on proportionally smaller support of emeriti than in the previous period (according to materials submitted to the committee there are 5 members older than 65 years, and 2 older than 70 years, at the end of the evaluated period of 2010-2014).

Declaration on the strategy and plans for the future

The future of the group in the present evaluation period is well planned and clear. A mere extrapolation of currently running projects will certainly keep the group busy for at least a decade and bring superb science results thanks to broad international collaboration.

Evaluation of the Team No. 2: Department of Stellar Physics

1. Introduction

The stellar physics group conducts research in several specific topics, namely observations and modelling of hot massive stars (O- and B-stellar classes), astrophysics of white dwarfs, theoretical analysis of radiative transfer in expanding envelopes of massive stars, and observations and modelling of high-energy sources such as low-mass X-ray and cataclysmic binaries. Apart from direct research activity, the group also operates the institute's largest instrument, namely the 2-m telescope. Smaller, but fully robotic telescopes were developed and are currently operated by the high-energy team. The hot stars team partly uses observational time allocated to the institute within the collaboration with Danish partners at their 1.54m telescope located at La Silla, Chile. Both observational teams have a standing collaboration with space-missions projects, such as Gaia, INTEGRAL, Swift, RHESSI etc.

2. Strengths and Opportunities

The group consists of teams, each of which has established an internationally renowned position. This is most apparent for the hot stars team, because this subject has been systematically developed at the stellar department since its beginning in 1960s. While some of the founders have left over the time, the current team does its best to continue this fruitful research. Collaboration with the radiative-transfer theory group, when done, is highly productive. The white-dwarf team is highly successful in obtaining observational time at large ESO facilities, certainly a sign of good science and an international recognition. The high-energy team has established significant international collaborations that allowed them to cooperate on several important observational runs (for instance monitoring gamma-ray burst optical afterglows, resulting in highly visible publications).

3. Weaknesses and Threats

The group seems less coherent body than, for instance, the solar physics group. Overlap between the individual teams activity is not very large, while partly existing between the radiation-transfer theory and the hot stars teams. The white dwarf and high-energy teams operate mostly on their own, while both are rather small units (in terms of staff). Additionally, the 2-m telescope, a major on-site facility, seems to be used mainly by the hot stars group only. However, this might be a result of only a limited amount of usable nights for astronomical observations in central Europe. The group also hosts the largest technician team at the institute, expenses of which should not influence judgement about science quality of the research performed by the group.

4. Recommendations

The main observational program of the 2-m telescope, long-term monitoring of B- and Be-stars, seems to be well-justified. However, it is beyond the expertise of the committee to judge if it provides the best ratio between the resulting science and cost. Perhaps an expert body might evaluate this issue at some moment in the future and provide specific recommendations.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The science results of the research teams are certainly visible in their respective fields. Basically all publications evaluated in the phase I are either exclusively written or lead by

members of the team in an international collaboration. Clearly the contribution of the team members is decisive.

Declaration on the involvement of students in research

The radiation-transfer and the high-energy astrophysics teams have very close collaboration with the Masaryk University in Brno and the Technical University in Prague (there were 11 Bc, 10 Master and 16 PhD theses lead by the team members of which 3 defended in the time interval 2010-2014). This brings a significant flow of master and PhD students to the group, as well as opportunity to teach classes at the respective institutions.

Declaration on societal relevance

This group is the least active in this respect when compared to the other groups at the institute.

Declaration on the position in the international and national context

Two members of this group represent Czech Republic in ESO committees, and dr. Kubát is a Czech representative in the Astronomy & Astrophysics editorial board.

Declaration on the vitality and sustainability

The group is very active in regards the college students in Brno and Prague TU.

Declaration on the strategy and plans for the future

The stated plans for the future period basically assume continuing the current work. This is fine as long as good quality results are produced. Hiring dr. Petr Kabáth, with the goal to extend the expertise toward the exoplanet observations and research, is a very good decision.

Evaluation of the Team No. 3: Department of Interplanetary Matter

1. Introduction

The interplanetary matter group conducts research in two domains of the planetary sciences: (i) meteor physics, and (ii) physical studies of asteroids and their multiple systems. While somewhat narrow, in both topics the group teams internationally excel. Continuing tradition founded by dr. Zdeněk Ceplecha in 1950s, the meteor group in one of 3 teams in the world that is capable to perform complex study of interplanetary matter flux onto the Earth. While the US and Canadian groups may have superior expertise for smaller particles, the Ondřejov group is arguably the world leader in analysis of the most energetic impacts of bright bolides. Unsurprisingly then, it has been called as an opinion leader for analysis of the most spectacular recent event, namely the Chelyabinsk impact. The asteroid group artfully combines theoretical and observational efforts based on international collaborations. As far as rotation data on asteroids, the Ondrejov team is generally considered as a worldwide reference home.

2. Strengths and Opportunities

The interplanetary matter group is the smallest department in the institute (in terms of staff members), but by far not the least visible (both in terms of publications in the highest-rank journals such as Nature or Science, and also general public outreach). This is because of a combination of an excellent and pointed research, with the fact that its topic is highly attractive to general public. The meteor group was recently awarded Academia funding that allowed to modernize the Czech/central European network of bolide cameras. With that instrumentation, and collaboration with British partner on operations of the Australian desert network, the team has an unprecedented tool for detection of bright bolides. The systematically improving theoretical tools for the data analysis ensure their maximum science utilization. It became nearly a standard that the best documented cases result in meteorite find as well as accurate pre-atmospheric orbit determination. These are the mostly praised results, because they allow a link between the meteorite (possibly subject to detailed geochemical analyses) and its potential source region in the Solar system. The asteroid team proved during the evaluation period 2010-2014 a remarkable flexibility in focusing their research on hot topics emerging from theoretical studies while also continuing the highly important research of binary and multiple asteroid systems.

3. Weaknesses and Threats

There are no manifest weaknesses in the group and in its outputs during the evaluation period. If anything has to mentioned, it is the size of the group. However, the age profile, skewed toward ages < 50 year, is promising for the group sustainability. The observational efforts of the asteroid group depend on the Ondřejov 65cm telescope and, in the last years, on operations of 1.54m Danish telescope on La Silla, Chile. It is important to ensure continuity of these operations, of which the latter requires annual funding and a continuous will of the Danish partner. Given the excellent science results, actions should be made to assure both.

4. Recommendations

There are no specific recommendations on the future operations of the group. The stated outlook for their activity in the 2015-2020 period is clear. It builds on expertise gained in the past years, extrapolates and proposes to explore several new topics. It also assumes a full utilization of available and modernized infrastructure (such as camera networks and telescopes dedicated to photometric observations). Combination of all these activities

promises excellent science results. Obviously, an institutional support of this efficient group needs to be assured.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The group's world leading position in meteor science and studies of rotation state of small asteroids and their multiple systems implies high-visibility and widely appreciated results. This is expressed not only by publications in journals with high-impact factor, but also invitations to contribute chapters in topical books. Given smallness of the group, the output is very efficient. Basically all publications evaluated in the phase I are either exclusively written or lead by members of the team in an international collaboration. Clearly the contribution of the team members is decisive.

Declaration on the involvement of students in research

Compared to other departments at the institute, the group is less active in delivering university or college courses and/or supervision of master- or PhD-level students (there were 2 Bc, 1 Master and 2 PhD theses lead by the team members of which 2 defended in the time interval 2010-2014). As to the meteor group, this might result from responsibility in maintaining and operation of large camera networks which requires a lot of manpower.

Declaration on societal relevance

The group is highly visible in society through their activity (e.g., TV, radio programmes, public lectures, school visits). This is because their results are easily shared and feed general public interest in astronomy. The outreach programme of this group is really impressive.

Declaration on the position in the international and national context

Both teams in this group are world-top in their own expertise.

Declaration on the vitality and sustainability

While the age profile of the group is manifestly skewed to young researchers, a slight attention needs to be paid to keep them in the team.

Declaration on the strategy and plans for the future

Given success of the group in what they are doing, the plan to continue and further develop their own, world-recognized expertise is sound.

Evaluation of the Team No. 4: Department of Galaxies and Planetary Systems

1. Introduction

The galaxies and planetary systems team focuses on three, somewhat disconnect topics: (i) dynamics and evolution of galaxies and their subsystems, star-formation in different environments (such as fragmenting hydrogen shells driven by winds from already formed massive young stars), galaxy mergers and implications of their observations for fundamental physics, (ii) relativistic astrophysics of compact objects (neutron stars and black holes) surrounded by interstellar medium (such as inflow structures from a companion star, accretion disks) and multispectral observations of Galaxy center hosting a supermassive black hole, and (iii) the Earth rotation analysis and space geodesy. Especially in the first two topics – (i) and (ii) – the teams are widely world-respected and visible.

2. Strengths and Opportunities

The first two teams, galactic astrophysics and relativistic astrophysics, have built very strong groups of predominantly young researchers whose work is internationally recognized in their field of expertise. The teams are frequently visited by short-term foreign scientists, which helps further to strengthen international connections. One may highlight the CALIFA collaboration and the FP7 Strong gravity project as excellent examples of such international visibility. Strength of the space geodesy team is in its well-established collaboration with teams running ESA missions, such as GOCE or Swarm (calibration of on-board precise accelerometers). All teams have a number of very active post-docs and young researchers.

3. Weaknesses and Threats

At the first sight, the group makes a bit strange “marriage” of the galactic and extragalactic astrophysics teams with the planetary system team. Moreover, the latter's name is partly “misspelled”, because it truly deals with the Earth rotation, and orientation of the Earth reference frame, and the space geodesy topics (missing a broader research of planetary systems). The committee understands that this situation probably has some history and it would be difficult to constitute the space geodesy team as a separate group/department in the institute. On the longer term, though, the structure of this group might be revisited by the institute authorities.

4. Recommendations

There are no specific recommendations to the proposed science in the 2015-2020 period. The topics are well-chosen and mostly built on excellent results achieved in the evaluated period of time. As to the administrative organization, a thought should be paid to the status of small space geodesy group. However, its science results are sound and well-planned for the future, so this comment should be understood as a positive suggestion.

5. Detailed evaluations

Declaration on the quality of the results and share in their acquisition

The group produces mostly excellent science results and coined its own “corner”, where their expertise is recognized and sought by foreign institutions. One may mention the topic of star-formation in galaxies, analysis of high-energy radiation spectra from accretion disks around black holes or analysis of structures in the Galactic center. Dr. Hadrava's codes for analysis of photometry and spectroscopy of binary and multiple star systems are “gold standards” for both Czech and many foreign stellar astronomers. The group has also

very long tradition and expertise in analysis of the Earth rotation and the inclination resonances in orbits of artificial Earth satellites. Basically all publications evaluated in the phase I are either exclusively written or lead by members of the team in an international collaboration. Clearly the contribution of the team members is decisive.

Declaration on the involvement of students in research

The galactic and relativistic astrophysics teams have lead a significant number of master- and PhD-thesis over the evaluated period of time, mostly students of Charles University in Prague and Masaryk University in Brno (there were 3 Bc, 8 Master and 15 PhD theses lead by the team members of which 6 defended in the time interval 2010-2014). The relativistic astrophysics team has also very close contacts with the Silesian University in Opava, with whom they regularly organize scientific workshops. Student exchanges or joint PhD programmes with foreign institutions (such as in Germany and France) were successfully completed. This helps the teams to keep a close contact with young generation of scientists and choose good candidates for future membership in the group. Both teams also hold a significant number of courses at both universities.

Declaration on societal relevance

The group is very active in outreach through public lectures, TV- or radio-programmes, or book translations. Some members conduct also highly-praised research in history of astronomy and paleoastronomy. The work of the space geodesy team offered a good opportunity of small high-tech companies to help building accelerometers for ESA missions, a small but significant achievement given the tough international competition in this field.

Declaration on the position in the international and national context

All teams are nationally leading and have an internationally well-established and respected reputation.

Declaration on the vitality and sustainability

The age structure of the teams is significantly skewed toward young researchers, which by itself is a very good quality. A potential danger though is that funding would not be available for all of them, although up to now the high-scientific quality of the group allowed to get a significant amount of grant money (provided both by the Czech science foundation and other institutions, including Academy itself). Status of the space geodesy group may be discussed within the institute. A couple of young and promising researchers should be a good argument to continue its support.

Declaration on the strategy and plans for the future

Science plans for the next period are sound and well explained. They combine extension of the currently running research and new ideas, as well as proposal for interesting observations using the leading facilities in ESO.

Date: January 13, 2016

Commission Chair: Prof. John Dainton