EXCOM 2015

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Astronomy and Astrophysics from Antarctica

(AAA)

Executive Summary

Title: Astronomy & Astrophysics from Antarctica (AAA)

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Introduction/ Background: Broadly stated, the objectives of Astronomy & Astrophysics from Antarctica (AAA) are to coordinate astronomical activities in Antarctica in a way that ensures the best possible outcomes from international investment in Antarctic astronomy, and maximizes the opportunities for productive interaction with other disciplines.

The SCAR AAA SRP Planning Group was proposed at the Hobart XXIX SCAR in 2006. Creation of the AAA SRP was approved at the Moscow XXX SCAR Delegates meeting in 2008. AAA held its first formal meeting as a Scientific Research Program in August 2010 in Buenos Aires, followed by a kick-off meeting in Sydney in June 2011. Further major meetings have followed in Portland (2012), Siena (2013) and Auckland (2014).

Important Issues or Factors: At this stage, AAA is functioning well, with no significant problems. We have recently replaced roughly half of our Steering Committee members as part of a planned rotation, and will replace the remainder in 2016.

Recommendations/Actions and Justification: None requested.

Expected Benefits/Outcomes: Based on the recommendations of the 2014 external review, AAA is placing a greater emphasis in future on outreach and education, both to the general community and to SCAR member countries with less developed astronomical programs. AAA has also organised an exhibition booth for the two-week duration of the upcoming International Astronomical Union (IAU) meeting in Honolulu. This booth will be staffed by volunteers, and aims to raise the profile of both SCAR and Antarctic astronomy within the broader astronomical community.

Partners: No formal partners, although the International Astronomical Union (IAU) is a Union Member of SCAR.

Budget Implications: Continuing funding is requested at the approved level.

SCAR AAA
Astronomy & Astrophysics from Antarctica

1. Rationale for the Programme

Astrophysical observations require minimum interference from the Earth's atmosphere: low thermal background, low absorption, and high angular resolution. Antarctica offers exceptionally good conditions found nowhere else on earth. This leads to programs that are aimed at understanding the overarching processes in the Universe, from the origin of structure in the first few moments after the Big Bang, to the nature of dark matter and the evolution of galaxies, to the birth and life-cycle of stars and of planetary systems around other stars.

There are three broad benefits offered by Antarctica:

1. The moderate "launch costs" for Antarctic plateau observatories make them an extremely attractive alternative to space,
2. The predicable paths followed by high altitude balloons at the edge of the polar vortex facilitates long-duration scientific balloon observatories,
3. The vast amounts of clean ice on the plateau make it ideal for particle physics experiments.

Astronomy & Astrophysics from Antarctica (AAA) adds value by fostering international collaboration in order to permit goals to be achieved that are beyond those of single national programs. In addition, AAA is actively fostering international cooperation in the Arctic, and is developing links between astronomers and researchers in other fields such as atmospheric physics and ionospheric science.
AAA is led by a Steering Committee, supported by four Working Groups.

2. Important Issues or Factors

i) Five Scientific Highlights

These five highlights from the past 18 months illustrate some of the breadth and scope of astronomical activities in Antarctica.

1. "The SUPERTIGER Instrument: Measurement of Elemental Abundances of Ultra-Heavy Galactic Cosmic Rays", W.R. Binns, W.R et al, *Astrophysical Journal* (2014), **788**, 18. Using a cosmic ray telescope flying aboard a long-duration balloon borne launched from McMurdo, cosmic rays consisting of ultra-heavy atomic nuclei have been detected and analysed.
2. "A Joint Analysis of BICEP2/Keck Array and Planck Data", P.A.R. Ade et al., *Physical Review Letters* (2015) **114**, 101301. The combined analysis of data from a millimetre-wave telescope at the South Pole station and a spacecraft at L2 is used to place strong constraints on the nature of cosmic "inflation".
3. "The Carbon Inventory in a Quiescent, Filamentary Molecular Cloud in G328", M. Burton et al., *Astrophysical Journal* (2014), **782**, 72. The *HEAT/PLATO* robotic observatory at Ridge A has made the first comprehensive study of the "missing" carbon in an important star-forming region.
4. "Meteorological Data for the Astronomical Site at Dome A, Antarctica", Yi Hu et al, *Pub. Astron. Soc. Pac.* (2014), **126**, 86. Astronomers and atmospheric physicists have collaborated to measure and analyse conditions in the lower atmosphere above Dome A.
5. "Transit Search from Antarctica and Chile – Comparison and Combination", T. Fruth et al., *Pub. Astron. Soc. Pac.* (2014), **126**, 237. A comparison of data from the Dome C station with similar data from Chilean observatories shows that, while the Antarctic site outperforms the Chilean site, the best option for searching for transiting extra-solar planets is to combine data from both sites.

ii) Progress against prior work plan, including metrics of performance.

The key objectives of the first four years of AAA were favourably reviewed at the Auckland SCAR meeting, leading to renewal of the program for an additional four years. Following this review, AAA has created a new work plan, as described below in Section 5. Implementation of this plan is underway; the most significant progress so far being the creation of outreach materials for the SCAR AAA booth at the International Astronomical Union booth in Hawaii, August 2015. Additionally, SCAR AAA now has an active Twitter account for outreach: @SCAR_AAA.

3. Outputs/Deliverables

Seven of AAA's most important achievements to date are:

1. Providing a forum for the evolution of plans for the development of an astronomical observatory at Kunlun station (Dome A). This has already led to the deployment there of a robotic observatory, which has returned not only a wealth of site testing data, but also significant new astronomical results from the CSTAR and AST-3 telescopes. It has also stimulated discussion of an international 2.5 metre class optical/infrared telescope to the high plateau. Called KDUST, the project is based around a Chinese-led consortium involving participants from Australia, China, France, Italy, Japan and the USA. While KDUST will most likely be sited at Dome A, the possibility of siting at Dome C has also been discussed.
2. Facilitating cooperation between US and Australian researchers, leading to the establishment of a new international observatory at Ridge A. Ridge A was chosen in 2009 on the basis of a study of existing satellite and meteorological data. In 2013 a US geophysics team used new satellite data to confirm Ridge A as the coldest place on earth. A robotic terahertz telescope, HEAT, is currently operating at Ridge A, creating the first detailed maps of the distribution of neutral and ionised carbon in star-forming regions.
3. Facilitating cooperation between Australian and Japanese researchers, leading to the establishment of a robotic observatory at Dome F. Data from Dome F confirm the same exceptionally good "seeing" conditions present at other high Antarctic plateau sites. In the next six-year plan (2016 – 2021), NIPR will construct a new station 60 km south of the current Dome Fuji station for ice coring, astronomy, and other scientific programs. The site is drier than the current station. Near-infrared and THz telescopes, which are now under budget request, will be the main facilities for astronomy.
4. Creation of a web-accessible database of all Arctic and Antarctic site-testing published to date. See: http://www.astronomy.scar.org/WorkingGroupA/scar-db.php
5. Encouraging observatory development plans on Ellesmere Island, Canada, and at Summit Camp, Greenland, by providing common venues for discussing successful polar robotic site-testing methods and inter-comparison of results.
6. Installation of a display booth at the International Astronomical Union (IAU) General Assembly in Honolulu (August 2015) to bring SCAR AAA activities – and those of SCAR more generally – to the attention of the world's astronomers.
7. Establishment and maintenance of an on-line presence at www.astronomy.scar.org

4. Budgetary Implications

Main Expenditure; any reasons for underspend; requested budget over next two years.

The four main areas of expenditure in 2014 – 2015 have been:

- Travel support for attendees to the SCAR AAA meetings in Auckland in August 2014
- Booking expenses associated with AAA workshop in Volcano, Hawaii in August 2015
- Travel support for attendees the AAA workshop in Volcano, Hawaii in August 2015

- Booking fees and printing expenses for the SCAR AAA booth at the IAU General Assembly in Honolulu, Hawaii, in August 2015.

There should be no under-spend once all travel grants for the Hawaii meeting have been disbursed. Continued funding at the allocated level is requested.

5. Future Plans

In its first four years, SCAR AAA has worked hard to meet its initial objectives; providing a forum to facilitate international cooperation, clarify science goals, consolidate comparative site testing data, and raise the profile of SCAR within the international astronomical community and the general public.

In its second four years, SCAR AAA wishes to build upon the progress made so far by developing a robust international platform for astronomical cooperation in Antarctica. Specifically, SCAR AAA takes on board the recommendations of the external reviewers in 2014, who called upon us to:

- Formulate a clearer vision with informative advice on what type of observations are needed where,
- Encourage collaboration by all countries towards new accomplishments, not repetition of existing results,
- Extend the site-testing database to cover astronomical data, including consideration of joining the Astronomical Virtual Observatory,
- Increase education/outreach, especially to general public, colleges, high schools, museums,
- Build more capacity in countries with less developed capacity.

From this, the following operational plan for 2014 – 2018 has emerged. The key goals for this period will be to:

I. Create an Antarctic Plateau International Astronomical Observatory (APIAO)
II. Extend the current site testing searchable database to become a data portal,
III. Increase outreach activities directed towards the general public and the international astronomical community, especially in those countries with less developed astronomical programs in Antarctica.

To implement this plan, SCAR AAA has reviewed its internal structure and concluded that its four working groups are currently well-suited to these tasks – no change is needed. However, some rotation of the key roles within SCAR AAA is desirable, especially if this can be done in a way that improves gender balance and generational representation. To implement this, we have recently replaced roughly half of our Steering Committee members as part of a planned rotation, and will replace the remainder in 2016.

Appendices

Current membership of the AAA SRP Steering Committee

Name	Nationality	Member until	Gender
Lyu Abe	France	2016	male
Jenni Adams	NZ	2018	female
Michael Ashley	Australia	2018	male
Jennifer Cooper	USA/APECS	2018	female
Xiangqun Cui	China	2016	female
Takashi Ichikawa	Japan	2016	male
Albrecht Karle	USA	2016	male
Silvia Masi	Italy	2016	female
Anna Moore	USA	2018	female
John Storey	Australia	2016	male
Charling Tao	France/China	2018	female
Lifan Wang	China	2018	male

AAA Working Groups:

- **Working Group A: Site testing, validation and data archiving.**
  - Chair: Tony Travouillon, Vice-chair: Jon Lawrence
- **Working Group B: Arctic site testing.**
  - Chair: Eric Steinbring, Vice-chair: Ming-Tang Chen
- **Working Group C: Science goals.**
  - Chair: Michael Burton, Vice-chair: Zak Staniszewski
- **Working Group D: Major new facilities.**
  - Chair: Peter Tuthill, Vice-chair: Xuefei Gong