



WP 10

Agenda Item: 4.3.1

Person Responsible: J. Storey

XXXIII SCAR Delegates Meeting

Auckland, New Zealand, 1-3rd September 2014

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) and Siena (2013).

Important Issues or Factors: At this stage, AAA is functioning well, as outlined in the Annual Report to delegates. There have been no significant problems.

Recommendations/Actions and Justification: AAA has submitted its Annual Report to external review this year. We request that a continuation of the AAA program be approved for another four years.

Expected Benefits/Outcomes: Based on the recommendations of the external reviews, AAA plans to place a greater emphasis in future on outreach and education, both to the general community and to SCAR member countries with less developed astronomical programs.

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

Annual Report 2014

1. Introduction

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 predictable 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. Deliverables and Milestones

I Up to five key achievements

While AAA would love to be able to claim credit for some of the recent spectacular astronomical breakthroughs [1 – 3], in reality the large experiments such as SPT, BICEP2 and IceCube were well underway before AAA was created. Such experiments, while partly international, have already reached a level of sustainability to which AAA can add only incremental benefit; for example by encouraging other countries to join in the next evolution of these facilities (such as SPT-3rd gen., BICEP3 and ARA and next generation IceCube). AAA sees its role more in the facilitation of new international projects, particularly those involving nations that have not traditionally had a large presence in Antarctic astronomy. To this end, all AAA workshops to date have had presentations from lead researchers in the most advanced projects, often to an audience of astronomers from countries with little or no Antarctic experience.

SCAR AAA tries to be as inclusive of the world community as possible, and has so far supported workshops in Australia, China, France, Italy and the USA. By using SCAR funds to seed workshop proposals, additional resources can often be obtained from other sources to further increase international participation.

Five 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 [4 – 8], but also significant new astronomical results [9 – 12] 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 [13]. 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 [14, 15] 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 [16] 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 [17]. 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 [18].
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 [19]. 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 [20].
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 [21, 22].

II. Primary publications in peer-reviewed journals

See Appendix 2.

III. Major reports, including linkages to major SCAR activities (e.g. advice to the Treaty or IPCC).

Astronomy & Astrophysics from Antarctica has not at this stage written any major reports. However, members of AAA make use of the knowledge base and network of contacts in providing input to national plans such as the Long Range Plan (Canada), the NIPR 6-year plan (Japan), the twelfth 5-year plan (China) and the Decadal Plan (Australia).

IV. Other reports and grey literature

None specifically authored by SCAR AAA.

V. Workshops and other key meetings

1. *Astronomy and Astrophysics from Antarctica Kick-off Meeting*

The SCAR AAA SRP held its kick-off meeting over three days at the Taronga Zoo in Sydney at the end of June 2011. A total of 51 people from 8 countries attended. (Additional funding for the meeting was provided by the Australian Antarctic Division, Astronomy Australia Limited, the Australian Astronomical Observatory, CSIRO, and the University of NSW.)

<http://www.astronomy.scar.org/AAA2011/>

2. *Workshop Astro-Antarctica*

This two-day workshop was held in Marseille, France, in September, 2011. It explored the options for international collaboration on a 2.4 metre class near-infrared telescope, with participants from Australia, China, France and Italy. (Additional funding for the meeting was provided by the Laboratoire Fizeau, Université de la Méditerranée and the Centre de Physique Théorique.)

<http://marwww.in2p3.fr/~tao/PLT/>

3. *NIR@ANT meeting*

This meeting, held in Beijing, China, from 7 – 9 November, 2011, created an international task force to carry forward the 2.4 metre class near-infrared telescope project – now called NIR@ANT. (Additional funding for the meeting was provided by the National Astronomical Observatories, Chinese Academy of Sciences.)

www.astronomy.scar.org/NIRANT/index.html

4. *SCAR OSC Portland*

Astronomy & Astrophysics from Antarctica met in Portland in July 2012 in the week prior to the Open Science Conference. Reports were presented from the four working groups. This was followed by a dedicated session at the OSC.

<http://scar2012.geol.pdx.edu/>

5. *IAU Symposium #288 “Astrophysics from Antarctica”*

This symposium, in Beijing (China) in August 2012, was organised entirely under the auspices of the IAU as part of its XXVIIIth General Assembly. It was a significant “first” for Antarctic astronomy, as IAU symposia are major events reserved for important emerging or fast-moving research topics. Many members of SCAR AAA presented invited talks, and AAA members were able to network with the nearly 3,000 astronomers from 80 countries present at the meeting.

<http://www.phys.unsw.edu.au/IAUS288/index.html>

6. *Collaboration Meeting on Antarctic Survey Telescopes*

Lijiang (Yunnan Province, China), August, 2012. This was the first of two international meetings held in China on progress in the Antarctic Survey Telescope (AST-3) project. AST-3 is a set of three 50-cm telescopes for deployment at Kunlun Station at Dome A. (Sponsored by Purple Mountain Observatory and the Polar Research Institute of China, no SCAR funding was required for the meeting).

<http://2012ast.csp.escience.cn/dct/page/65580>

7. *Second Collaboration Meeting on Antarctic Survey Telescopes*

Tengchong (Yunnan Province, China), May, 2013. (Sponsored by Purple Mountain Observatory and the Chinese Center for Antarctic Astronomy, no SCAR funding was required for the meeting).

<http://2013ast3.csp.escience.cn/dct/page/65580>

8. *Second Workshop on the SCAR AAA Scientific Research Program.*

This meeting, in July 2013, was held at Certosa di Pontignano, a former Carthusian Monastery on the outskirts of Siena, Italy. It attracted 50 participants from ten countries. (Additional funding for this meeting was provided by the Italian Programma Nazionale di Ricerche in Antartide, the University of Rome and the University of Siena).

<http://www.astronomy.scar.org/AAA2013/index.html>

VI. **Capacity building and education activities**

The main visibility of AAA is through the website <http://www.astronomy.scar.org>. AAA is also publicised at major international astronomical meetings, such as those of the International Astronomical Union, through posters and talks. SCAR members promote Antarctic astronomy within their own national communities, and as invited speakers in countries that do not yet have a significant Antarctic astronomy program such as Korea.

The establishment of Ridge A observatory as an international station by the US and Australia, with the SCAR flag proudly flying above the observatory, is a striking symbol of international cooperation in Antarctica. The image has been widely published in journals, magazines and on-line forums.

VII. New data and/or meta-data (including plans for archiving)

All published papers reporting site-testing results from both Antarctica and the Arctic have now been recorded on a web-accessible database. Maintaining this database in future will be a key activity of AAA, as will extending it to include access to the data themselves.

VIII. Brochures, and other PR material

None as yet.

IX. Linkages to other SCAR groups, international programmes and other activities

The International Astronomical Union (IAU) is a union member of SCAR. SCAR AAA provides a report to the IAU each year or on request.

X. Expenditure on project activities and plans for unspent funds.

The only non-travel expenditure has therefore been an allocation of USD8,000 to support postgraduates inputting data to the database. All other SCAR funds are used to support international meetings and workshops. This has allowed AAA to maintain a vigorous program of engagement within both the Antarctic community and the broader astronomical community. As noted earlier, using the SCAR resources as seed funding results in substantial leverage, with other organizations often sufficiently encouraged that they make significantly larger financial contributions. In some cases, this leads to AAA being able to carry funds over for the next meeting, where they can support travel – especially for astronomers in countries where such support is not generally available.

The SCAR AAA website is hosted by the School of Physics at UNSW, Australia, at no cost to SCAR. Special thanks are due to George Hatsidimitris for maintaining the site.

3. Future Plans

Overall management

- Implement phased rotation of the SRP steering committee membership.
- Organise Third AAA Workshop in mid 2015.

Working Group A: Site testing, validation and data archiving.

- Expand the web-accessible database of site testing papers to include:
 - links to the data themselves, wherever possible.
 - links raw astronomical data where this is available
- Coordinate efforts that address major technological hurdles (Humidity; ground layer seeing (GLAO); Building Towers)

Working Group B: Arctic site testing.

- Enhance the direct comparison of polar site-testing programs by sharing of characterization results.

Working Group C: Science goals.

- Assist in the development of new facilities by continuous refinement of the science case, taking into account the rapid evolution both of Antarctic and space-based observatories.

Working Group D: Major new facilities.

It is the goal of Working Group D to facilitate collaborative efforts to launch world-class instrumentation projects for Antarctic deployment. Ultimately, one ambitious vision put forward by this working group is the establishment of an international high plateau research station which may serve to democratise access to this immense scientific promise, and to yield most efficient use of the logistical support chains required to support research activities.

- Continue building international support for a 2.5 metre class optical/IR telescope on the high plateau.
- Facilitate the development of optical/infrared inteferometry concepts such as the Planetary Formation Imager. <http://www.planetformationimager.org/>
- Explore further advancement of the international high plateau research station concept (Ridge A).
- Share knowledge for infrastructure support (e.g. power, communications)
- Facilitate instrument sharing between bases
- Build support for pushing beyond mature areas of present strength (Astro-Particle; CMB; Meteors) to areas of new promise (THz; IR; WideField Imaging; Continuous Cadence observing; Interferometry).

March 2014

Lead author: jwvs

Appendices

Appendix 1 – Committee Membership

Members of the AAA SRP Steering Committee

Name	Nationality	Member until	Gender
Michael Andersen	Denmark	2014	male
Philip Anderson	United Kingdom	2014	male
Michael Burton	Australia	2014	male
Xiangqun Cui	China	2014	female
Lyu Abe	France	2015	male
Takashi Ichikawa	Japan	2014	male
Albrecht Karle	USA	2014	male
James Lloyd	USA	2014	male
Silvia Masi	Italy	2014	female
John Storey	Australia	2014	male
Hongyan Zhou	China	2015	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: Michael Andersen

Working Group C: Science goals.

- Chair: Michael Burton, Vice-chair: Hans Zinnecker

Working Group D: Major new facilities.

- Chair: Peter Tuthill, Vice-chair: Xuefei Gong

Appendix 2 – References

The first three references are to recent astronomical breakthroughs from Antarctica, and are included to illustrate the importance of Antarctic observatories to the field as a whole. The other references are a sampling of recent work that has been facilitated at least in part by SCAR AAA.

- [1] "Detection of B-mode Polarization in the CMB with Data from the SPT", D. Hanson et al., *Physical Review Letters* (2013), **111**, 141301
- [2] "First Direct Evidence of Cosmic Inflation" <http://www.cfa.harvard.edu/news/2014-05>. See also: http://bicepkeck.org/b2_respap_arxiv_v1.pdf
- [3] "IceCube pushes neutrinos to the forefront of astronomy"
<http://icecube.wisc.edu/news/view/171>
See also: M.G. Aartsen et al. *Science* (2013), **342**, 1242856
- [4] "Exceptional Terahertz Transparency and Stability above Dome A, Antarctica", H. Yang et al., *Publ. Astron. Soc. Pacific* (2010), **122**, 490.
- [5] "Thickness of the Atmospheric Boundary Layer Above Dome A, Antarctica, during 2009", C. Bonner et al., *Publ. Astron. Soc. Pacific* (2010), **122**, 1122.
- [6] "The sky brightness and transparency in i-band at Dome A, Antarctica", Hu Zou et al., *Astronomical Journal* (2010), **140**, 602.
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- [15] "Transit Search from Antarctica and Chile - Comparison and Combination", T. Fruth et al., *Publ. Astron. Soc. Pacific*, (2014, in press)
See also: <http://adsabs.harvard.edu/abs/2014arXiv1403.1780F>
- [16] "Where is the best site on Earth? Domes A, B, C and F, and Ridges A and B", W. Saunders et al (2009), *Publ. Astron. Soc. Pacific*, **121**, 976.
- [17] "Coldest spot on Earth identified by satellite"
<http://www.bbc.co.uk/news/science-environment-25287806>
- [18] "The Carbon Inventory in a Quiescent, Filamentary Molecular Cloud in G328", M. Burton et al., *Astrophysical Journal* (2014), **782**, 72.
- [19] "Excellent daytime seeing at Dome Fuji on the Antarctic plateau", H. Okita et al., *Astronomy & Astrophysics*, (2013), **554**, L5.

- [20] “The SCAR AAA site testing database”, G. Sims. The site-testing database is freely accessible online at: <http://www.astronomy.scar.org/WorkingGroupA/scar-db.php>
- [21] “225 GHz Atmospheric Opacity Measurements from Two Arctic Sites”, Matsushita, S., Martin-Cocher, P., Asada, K., Chen, M.-T., Chen, C.-P., Inoue, M., Paine, S., Turner, D. & Steinbring, E., IAU Conference Series, Symposium 288, '*Astrophysics from Antarctica*' (2013), 204.
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