



**WP** 9

Agenda Item: 2.3.2

Person Responsible: Storey

**EXCOM 2013**

**Barcelona, Spain 22/23<sup>rd</sup> July 2013**

# **Astronomy and Astrophysics from Antarctica**

**(AAA)**



## Executive Summary

**Title:** Astronomy and Astrophysics from Antarctica (AAA)

**Authors:** John Storey (Chief Officer) with input from the Working Group chairs.

**Introduction/ Background:** The Astronomy and Astrophysics from Antarctica (AAA) SRP was launched in 2010 in recognition of the rapidly growing level of international activity in Antarctic astronomy, and the desirability of improved cooperation and coordination in this field.

The SRP carries out many of its activities on-line, holding a major face-to-face meeting every two years – alternating with the SCAR OSC.

**Important Issues or Factors:** At the present time AAA is functioning well. There have been a couple of changes to the membership of the Steering Committee, but otherwise there has been little deviation from the original Implementation Plan.

**Recommendations/Actions and Justification:** No new actions required at this stage.

**Expected Benefits/Outcomes:** The overarching goals of AAA are to add value to national research programs in Antarctic astronomy and astrophysics, and to maximise productive interaction with other disciplines.

**Partners:** No formal partners. The IAU (International Astronomical Union) is a Union Member of SCAR.

**Budget Implications:** Continued funding at the standard SRP level of \$20,000 is requested.

## **Astronomy and Astrophysics from Antarctica SRP**

### ***Background***

The SCAR AAA SRP Planning Group held two meetings during 2009: in Frascati, Italy and in Rio de Janeiro, Brazil; and a further meeting in 2010 in Buenos Aires, Argentina.

The Steering Committee has the following members:

Lyu Abe	(France) – replacing Nicolas Epchtein
Philip Anderson	(United Kingdom)
Michael Burton	(Australia)
Xiangqun Cui	(China)
Takashi Ichikawa	(Japan)
Albrecht Karle	(USA)
James Lloyd	(USA)
Silvia Masi	(Italy)
John Storey	(Australia) – Chief Officer
Hongyan Zhou	(China) – replacing Lifan Wang

### ***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. The web site for this meeting is hosted by UNSW and is accessible at:

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

Twenty-six contributed talks were given, including site-testing reports from several Antarctic sites and from the Arctic, recent scientific results, and ambitious proposals for new research facilities. For the final afternoon the meeting broke into the four Working Groups to discuss their implementation plans. The meeting concluded with plenary presentations by each of the WG conveners.

The most important task identified for AAA was to add a searchable site-testing data portal to the AAA website. This page would link to the locations of all existing data, as a first step towards the creation of an enduring database. A presentation by Miles Jordan from the Australian Antarctic Division helped delegates to better understand SCAR's data policy and how astronomers can best contribute to, and benefit from, data preservation.

### ***Portland meeting***

The SCAR AAA SRP met in Portland in 2012 in the week prior to the Open Science Conference. Reports were presented from the four working groups. The task of creating a web-accessible database of site-testing data was assigned to PhD student Geoff Sims, under the direction of Tony Travouillon.

### ***Future meetings***

The next meeting of SCAR AAA will be held in Siena, Italy from 24 – 26 July 2013. Approximately 50 people from ten countries have registered for the meeting, which will take place at the historic Certosa di

Pontignano, a former Carthusian Monastery on the outskirts of Siena. Additional funding for this meeting has been generously provided by the Italian Programma Nazionale di Ricerche in Antartide, with logistic support kindly provided free of charge by the University of Rome and the University of Siena.

The website for this meeting is:

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

### ***Working Group reports***

The four Working Groups of AAA are:

- Working Group A: Site testing, validation and data archiving.
  - Chair: Jon Lawrence, Vice-chair: Tony Travouillon
- 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 (TBC)
- Working Group D: Major new facilities.
  - Chair: Peter Tuthill, Vice-chair: Xuefei Gong

The reports from each of the Working Groups follow below.

### ***Working Group A: Site testing, validation and data archiving***

#### **1. Overview (Report provided by Tony Travouillon)**

Under the leadership of Working Group A: Site testing, validation and data archiving, a new on-line database has been created. This fully searchable database will eventually contain every paper written on astronomical site testing in both Antarctica and the Arctic. Currently there are over 230 entries, dating from the 1980s to the present time. Work is now underway to link directly from the publication database to the data themselves, creating a metadata portal. The web page is now live and is freely available to the community at:

<http://www.astronomy.scar.org/WorkingGroupA/scar-db.php>

AAA plans to extend the scope of the page to include a portal to astronomical data as well as to site-testing data, and has taken the first steps towards this goal. The acquisition of site testing data continues at the South Pole station, Dome A, Dome C, Dome F and more recently at Ridge A.

#### **2. Australian Activities in July 2011 – Jun 2013 (Report provided by Michael Ashley)**

The principal Australian astronomical activity in Antarctica involves the design, construction and operation of the autonomous PLATO observatories and their associated instruments on the high Antarctic plateau. Three such observatories are currently operating: PLATO-A at Dome A (in conjunction with China), PLATO-F at Dome Fuji (with Japan), at PLATO-R at Ridge A (with the USA).

During 2012 PLATO-A at Dome A successfully supported the Chinese AST 0.5m optical telescope. Nearly 30,000 images totalling 1.8TB were obtained in the first half of 2012. Papers were published from earlier data on the precipitable water vapour, airglow and aurorae at Dome A.

PLATO-F at Dome Fuji was idle during 2011, but was revisited by a Japanese traverse over the 2012/13 summer. A DIMM telescope was installed, and excellent seeing conditions were found – a paper has

been submitted to Astronomy and Astrophysics letters. An auroral camera built by Prof. Miyaoka of the Japanese National Institute of Polar Research is operating with PLATO-F support during 2013.

PLATO-R was designed and built in the second half of 2011 and was deployed to Ridge A in January 2012 using a Twin Otter aircraft and USAP logistics. PLATO-R supports the HEAT 60cm terahertz telescope HEAT built by Craig Kulesa's group at the University of Arizona. PLATO-R/HEAT ran successfully for over 120 days in 2012. The data is now on-line and available to interested researchers for collaboration. In January 2013, PLATO-R was serviced, and HEAT was upgraded to a two-channel spectrometer to simultaneously observe the [CI] line at 492 GHz and CO J=7-6 at 806 GHz. HEAT is currently surveying the Galactic Plane.

At the time of writing (end May, 2013) all three PLATOs are operating normally.

UNSW researchers are also collaborating with Dr Anna Moore of Caltech on the Gattini-SP experiment at the US South Pole station to measure the UV brightness of the sky.

## 2. Chinese Activities in July 2011 – Jun 2013 (Report provided by Lifan Wang)

The Chinese astronomical activity in Antarctica focuses on the construction and integration of the first of the three AST3 telescopes at Dome A. In August 2011, the telescope was installed at Xu Yi Station of Purple Mountain Observatory and engineering observations were conducted for two months there. The telescope was sent aboard the Xuelong Icebreaker in November 2011 for Dome A, together with the PLATO-A platform built by University of New South Wales. Integration at Dome A was successful and the telescope worked properly from January 2012 to the beginning of May 2012. The data were retrieved from Dome A by the 2012 – 2013 traverse and were made available to AST3 teams in China and Australia in May 2013. The scientific value of these data is still being evaluated. The 2012 – 2013 traverse attempted to restore the operation of AST3-1, but was unsuccessful.

The Chinese team also completed the construction of the second AST3 telescope. This telescope was tested at Xinglong Station during the winter time. The team has also looked for a site at Mohe (China) where winter temperatures regularly reach -40 C for winterization of the telescope. This telescope is expected to be ready for Dome A installation during the 2013 – 2014 traverse.

Other activities involve the analyses of CSTAR and GATTINI data. A paper on photometry of variable stars was published<sup>1</sup>.

## 3. French Activities in 2012 - 2013 (Report provided by Lyu Abe)

**Field activities at Dome C/Concordia station.** The AstroConcordia site-testing program was run during the winter 2012. It comprised the following instruments operating continuously: DIMM-isop (ground level, isoplanatic measurements), DIMM (8m height), DIMM-toit (20m height), PBL (lunar limb profiler) and 3 SONIC anemometers (attached to a 45m mast). Data of DIMMs are being analyzed. SONIC data confirm previous results that the planetary boundary layer at Dome C is about 30m in average.

The PBL instrument has been installed at Dome C in Antarctica since January 2011. An example of results obtained with the PBL during the winter 2011 at Dome C is shown in the figure below and compared to median profile of radio-sounding balloons measurements during the 2005 winter campaign.

The AstroConcordia site-testing program has unfortunately been terminated. However, the PBL instrument was granted special permission to continue observations in winter 2013. Also, the PAIX photometer (focused on RR-Lyrae variable stars) has not been operated in 2012 and 2013 due to technical difficulties and lack of operational support (only 1 winterover in 2012 and 2013). This program will be operational again in 2014 with a more automated instrument (program accepted by the French polar agency IPEV).

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<sup>1</sup> Wang, et al. 2011, AJ, 142, 155.

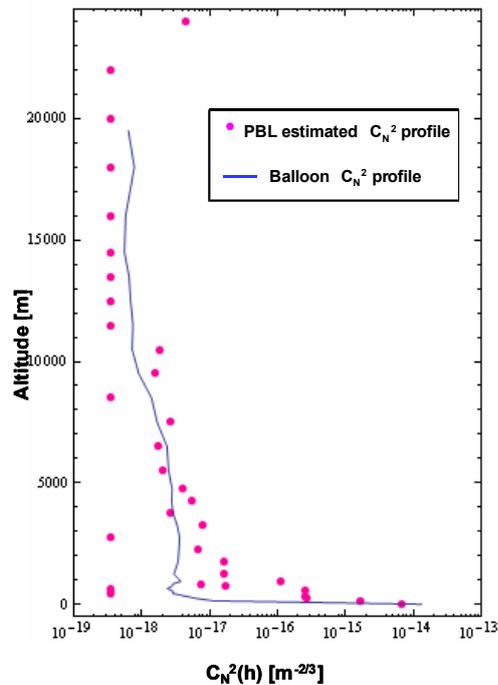


Figure 1.  $C_n^2$  profile measured by the PBL instrument (pink dots) and compared with 2005 radio-sounding balloons measurements (blue line).

The ASTEP program is active since 2008 with 2 instruments (ASTEP-South, fixed 10cm refractor, and ASTEP 400, a 40cm equatorial telescope). We published the results from the ASTEP 400 observation of the occultation ("secondary transit") of the WASP-19b planet with a depth of 0.04% (see Abe et al.<sup>2</sup>). Our exoplanet transit search program resulted in about 10 planetary candidates that are being checked for radial velocity confirmations in 2013.

A huge benefit of the Concordia Station is the permanent Internet connection (available from the end of 2012). It allows us to connect there using a VPN tunnel and ssh. We can now even punctually check and control our instruments when needed using a simple remote desktop.

#### **Antarctic instrumentation projects.**

The Paris team at LATMOS (lead by Luc Damé) is planning to install a small solar coronagraph prototype (ESCAPE project) in collaboration with Italian teams in 2015-2016.

The Lyon observatory in collaboration with the Observatoire de la Côte d'Azur has worked on a project of a small 50cm off-axis infrared prototype telescope and is awaiting funding decision in June 2013 (French ANR funding proposal).

#### **4. Japanese Activities in 2012 - 2013 (Report provided by Takashi Ichikawa)**

There has been continued collection of site testing data at Dome F with a suite of instruments and PLATO-F, which were installed in 2010/2011 and measured boundary layer turbulence, meteorology, and sky brightness for 5 months from February until June, 2011. On the expedition in 2012/2013, Japanese astronomy group retrieved the collected data on site. After PLATO-F was repaired, the Dome F observatory continues again collecting the data. PLATO-F is in its second season of operation at Dome F with collaboration of Australia. New instruments are two aurora cameras with a fisheye lens. The cameras will provide us the images to evaluate the aurora effect to optical observations at Dome F in aurora oval.

<sup>2</sup> Abe L. et al., *Astronomy & Astrophysics*, Volume 553, id.A49, 14 pp.

A new important result emerged from the site testing program with DIMM<sup>3</sup>. We observed the seeing in the visible wavelength at 11 m above snow surface at Dome F during austral summer 2012/2013. Some excellent seeings smaller than 0.2" were observed and continued for several hours at midnight. The excellent seeing observed at 11 m snow surface suggests that the surface boundary layer is as thin as a dozen or so meters. A telescope on a tower could easily access the superb free-air seeing. Full-automatic algorithm of DIMM makes possible to observe continuously. However, the observation in winter stopped due to a communication failure.

The Japanese astronomical activity in Antarctica involves the design of 2.5m infrared and 10m THz telescopes. The Japanese astronomical community has just reviewed all current and future plans for telescopes and instruments. The review gives our Antarctic telescopes a strong endorsement. The program "Astronomy on Dome F" has been continued since 2010. However, the activity could be delayed at least for two years due to the incident that recent thick ice near Syowa Station hampered the icebreaker Shirase coming alongside the berth and limited the conveyance by ice.

### **Working Group B: Arctic site testing**

Collection of site-quality data has continued at the Polar Environment Atmospheric Research Laboratory (PEARL; 80N, 610m elevation) near Eureka on Ellesmere Island. Differential Image Motion Monitor (DIMM) and Multi-Aperture Scintillation Sensor (MASS) measurements were obtained during campaigns in 2012. These, combined with two winters of lunar scintillometer profiler data point to a thin boundary layer and remarkably good overall nighttime seeing considering the relatively low elevation of the site: a median of 0.72 arcsec from the 6-m-high PEARL roof. At the same location, autonomous monitoring of J-band sky surface brightness was carried out over winter 2012/2013. In conjunction with that, two robotic Arctic Wide-Field Cameras (AWCams) continuously imaged upwards of ~1200 square degrees, tracking bright stars near the Pole, and first results on a known eclipsing binary appear in the *Astronomical Journal*. A feasibility study of operating a comparable instrument on a higher mountain – which necessarily involves helicopter logistics – is reported in the Proceedings of the 2012 Amsterdam SPIE meeting.

The Greenland icecap is the focus of a new northern hemisphere site for Very Long Baseline Interferometry (VLBI). An automated 225 GHz radiometer from ASIAA has been taking regular measurements from the upper platform of the Mobile Science Facility (MSF) at Summit Camp (72N, 3200m elevation) since summer 2011, after a short deployment in late winter at PEARL/Eureka. The results of the first winter are published in the Proceedings of the AAA Symposium 288 as part of the 'Arctic Analogue.' Best conditions at Summit appear to be comparable to South Pole. A modified ALMA 12m antenna is now being prepared for Summit with studies ongoing related to deployment and operation.

### **Working Group C: Science goals**

#### **Implementation Plan (Report provided by Michael Burton)**

The first ever Symposium held in the field of astronomy in Antarctica was sponsored by the International Astronomical Union as part of the IAU's triennial General Assembly in Beijing, China. IAU Symposium 288 "Astrophysics from Antarctica" was held from August 20-24, 2012. The meeting covered all aspects of astronomy in Antarctica. This included sessions on the characterization of Antarctica as a site for astronomical observations. The centre pieces of the Symposium were the sessions on the astronomical science that has been carried out in Antarctica – in the fields of the cosmic microwave background radiation, of high energy astrophysics (especially neutrinos), meteorites, optical and infrared astronomy, and of sub-millimetre and terahertz astronomy. Presentations were also given by the Directors (or their representatives) of the national Antarctic programs which are running astronomical facilities in Antarctica. These included talks on the Amundsen-Scott South Pole Station, Kunlun Station (Dome A), Concordia Station (Dome C) and Fuji

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<sup>3</sup> H. Okita, T. Ichikawa, M.C.B. Ashley, and N. Takato "Excellent daytime seeing at Dome Fuji in the Antarctic plateau" 2013, A&A, in press.

Station (Dome F), as well as the Long Duration Balloon Facility at McMurdo Station.

SCAR Vice-President Sergio Marenssi also spoke on the broad scale picture of Antarctic science conducted under the auspices of SCAR. The meeting also had a session devoted to the “Arctic analogue”, exploring the conditions on the summits of several Arctic islands that provide comparable conditions to Antarctica for some astronomical observations. Finally the Symposium finished with a discussion on future plans for Antarctic astronomy, in particular some of the developments underway in Australia, China, France, Japan and the USA aimed at building optical/infrared and sub-millimetre/terahertz telescopes on the summits of Antarctic high plateau. The Proceedings of the Symposium have been published by Cambridge University Press (Burton, Cui & Tothill, 2013)<sup>4</sup>. Copies of many of the presentations are also available at the Symposium website:

[www.phys.unsw.edu.au/IAUS288](http://www.phys.unsw.edu.au/IAUS288)

Two international meetings have also been held in China on progress in the Antarctic Survey Telescope (AST-3) project. This is a set of three 50-cm telescopes for deployment at Kunlun Station at Dome A. These meetings were held in Lijiang (Yunnan Province) from August 15–17, 2012 and in Tengchong (also Yunnan Province) from May 26–28, 2013.

### **Working Group D: Major new facilities (Report provided by Peter Tuthill)**

A report by WG D has suggested construction of an International High Plateau station on the Antarctic plateau, with a relatively open-door policy to national membership from a wide range of countries. This follows the trend of international astronomical observatories such as the Gemini partnership or the European Southern Observatory. Much of the same logic applies, with immediate and profound advantages gained by sharing infrastructure and creating a crucible for cross-fertilization with scientists from many nations working together. This is surely a recipe for the construction and maintenance of healthy international collaborations.

Such an International High Plateau Station would have strong resonance with the spirit of the Antarctic Treaty itself. Perhaps most importantly of all, it would provide a vehicle for smaller countries (such as Indonesia or Denmark) with Antarctic aspirations to share the otherwise prohibitive costs of running an entire program alone. The democratization of access to the Antarctic would surely yield long term benefits with a far wider national demographic to draw upon for new ideas in the exploration of the scientific potential of working there.

WGD has also established an international task force, NIR@ANT, to explore the design and construction of an international proposal for the construction of a 2.4 metre class near-infrared telescope, called NIR@ANT.

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<sup>4</sup> “Astrophysics from Antarctica”, 2013. International Astronomical Union Symposium No. 288, held during the XXVIII General Assembly of the IAU, Beijing, China, August 21-25, 2013. Editors Michael Burton, Xiangqun Cui and Nicholas Tothill. Publisher: Cambridge University Press.