WORKING GROUPS OF THE EXECUTIVE COMMITTEE

Encouraging the International Development of Antarctic Astronomy

Planetary system nomenclature

World wide Development of Astronomy

Future Large Scale Facilities

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ANTARCTIC ASTRONOMY

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1. Introduction

The Antarctic plateau provides the best site conditions on the Earth for a wide range of astronomical observations, both of photons and particles. This is a result of the unique combination of cold, dry and tenuous air found only there. Wintertime temperatures average below -60°C, with minimal diurnal variation, the precipitable water vapour content is below 250 μm, the katabatic wind is low on top of the plateau and there are no jet streams at high altitude. The vast quantities of pure ice can be used as an absorber for particle detectors. Secondary benefits include continuous viewing for any source visible, lack of pollution and dust in the atmosphere, and low electromagnetic interference. Considerable activity is now focussed at the South Pole on developing facilities for astronomy. Initial investigations of higher sites have begun, particularly at Dome C.

2. South Pole Observatory (2,900 m)

Two principle astronomical activities are underway at the Amundsen–Scott South Pole station, operated by the National Science Foundation of the USA, those of CARA and of AMANDA. Scientists from Australia, France, Germany, Sweden and the UK also participate in these projects.

2.1. CENTER FOR ASTROPHYSICAL RESEARCH IN ANTARCTICA

AST/RO, the 'Antarctic Sub-mm Telescope / Remote Observatory', a 1.7–m diameter sub-mm telescope, was commissioned in 1995. It has surveyed the southern Milky Way in the 492 GHz [CI] line, only observable infrequently from other good observing sites. Carbon emission has been found to be widespread and at least as extensive as regions of CO emission. The first detection of [CI] from the Magellanic Clouds has been made. Lines as weak as 0.02 K have been measured.

COBRA, the 'Cosmic Background Anisotropy Experiment', using the 0.75–m Python telescope, has reliably reproduced structure observed in the CMBR on angular scales from 0.75° to 5.5° over 4 successive austral summers. The sky coverage has been increased from 8 to 123 square degrees in that time. Significantly greater anisotropy is detected on degree scales than found by the COBE satellite at 20°.

SPIREX, the 'South Pole Infrared Explorer', a 60–cm near–IR telescope, was installed in 1994. SPIREX has achieved exceedingly dark backgrounds at 2.4 μm, as low as 23.5 mags/arcsec^2 for long integrations. It enjoyed a nearly uninterrupted view of the collisions of Comet Shoemaker–Levy with Jupiter. Only 4 of 20 events were obscured by clouds and over 3,000 images were obtained. These were also transferred back to the 'mainland' during the event over the internet, demonstrating the level of communication links that are now established to Pole.

A comprehensive series of site testing measurements have been conducted at the South Pole, demonstrating the quality of the site. The 25% quartile for ppt H_2O in winter is 0.19 mm, compared to 1.05 mm on Mauna Kea. Both SPIREX and an Australian experiment, the IRPS ('Infrared Photometer Spectrometer'), have measured the sky brightness in the 2.29-2.46μm window, where airglow emission is minimal. It is found to be typically 100 μJy/arcsec^2, a factor $\sim$ 40 times lower than Mauna Kea. In the L–band, 3-4 μm, the sky brightness is typically 20-100 mJy/arcsec^2, a factor $\geq$ 20 times lower than good mainland

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sites. Above a surface inversion layer typically 200 m high, the mean visual seeing is 0.36". The isoplanatic angle is $\geq 5'$ at 2.4 μm.

2.2. ANTARCTIC MUON AND NEUTRINO DETECTOR ARRAY

AMANDA is designed to observe high-energy ($\sim$ 1 TeV) neutrinos. Strings of widely spaced photomultiplier tubes (PMTs) are placed into deep water-drilled holes in the ice. High energy neutrinos coming up through the earth will occasionally interact with ice or rock and create a muon. The Cerenkov photons produced are tracked by the PMTs.

During 1994 four strings were placed in the ice, with PMTs from 800–1000 m in depth ('AMANDA-A'). Four more strings were deployed in 1996 at 1600–2000 m depth ('AMANDA-B'). Optical properties of the ice have been determined. It has an extraordinarily long absorption length, $\sim$ 150 m. The scattering length is nearly two orders of magnitude higher at the lower depth, $\sim$ 25 m.

SPASE, the 'South Pole Air Shower Experiment', continues to monitor cosmic rays above 100 TeV with two arrays and is using the muon detection capability of AMANDA, together with an air-Cerenkov detection system, to measure the mass composition of cosmic rays above 1000 TeV. The second array, SPASE-II, was constructed in 1995 and placed 300 m from AMANDA, to assist with the coincidence timing in screening for neutrino detections.

3. Dome C (Circe, Concorde or Charlie; 3,200 m)

A French–Italian collaboration started construction of a station on this site in 1995. Currently an ice-core drilling operation is underway. The first winter-over is scheduled for 2,000. Daytime measurements of the micro-turbulence in the atmosphere were conducted in 1996.

4. Other Sites

On the 2,960 m elevation Hercules Névé, near the Italian Terra Nova station, measurements of the mid-IR sky emission have been carried out, as a trial for operating an instrument at Dome C, using a 0.8 m telescope and liquid ^{4}He cooled photometer.

Australia operates a cosmic ray research station at Mawson, containing a neutron monitor and muon telescope.

At the Argentinian Belgrano Base an 11" Celestron telescope has been operated, recording seeing measurements and determining atmospheric extinction coefficients.

5. Further Information

The following URL's provide links to web pages which serve as resources for further information on this subject area:

AMANDA	http://dilbert.lbl.gov/www/amanda.html
CARA	http://pen.k12.va.us/~alloyd/CARA.html
JACARA	http://www.phys.unsw.edu.au/~mgb/jacara.html

Volume 13 of the *Publications of the Astronomical Society of Australia* (1996) is devoted to articles on Antarctic astronomy. In addition to the WGDAA of the IAU, SCAR, the 'Scientific Committee for Antarctic Research', have established a sub-committee, STAR, 'Solar Terrestrial and Astrophysics Research', to coordinate astronomical activities in Antarctica.