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THE UNIVERSITY OF
NEW SOUTH WALES

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05 December, 2004

The Secretary

Joint Standing Committee on National Capital and External Territories
Parliament House
Canberra, ACT 2600
Attn: Quinton Clements

**Submission to the Inquiry:**
**Is Australia's Antarctic Program receiving adequate funding?**

Dear Quinton,

**Executive Summary**

This submission to the Joint Standing Committee on National Capital and External Territories comes from the Antarctic astronomy research group at the University of New South Wales. We first describe our group, and the experience and perspective we have on the Antarctic science program. We then outline the science that is driving our research program. The main part of the submission then provides input to the inquiry on the following issues:

- Funding for Antarctic Research Programs. We comment on both the difficulties of funding new research programs, and on the limitations of the existing Antarctic research grants scheme.
- Air Links. We discuss how essential such links have been to the conduct of our own research program, and the potential that air links provide.
- International Comparisons. We compare the allocation process for the science part of the Australian Antarctic budget with that of the USA.
- Constraints in Meeting Goals. We discuss how government guidelines constrain the types of science that can be undertaken within the national program.
- Capability and Resource Needs. We propose that Australia should become an active partner in the new high plateau station of Concordia, at Dome C in the Australian Antarctic Territory.

**The UNSW Antarctic Astronomy Group**

Our group is a part of the School of Physics at the University of New South Wales and has been conducting research in Antarctica for 10 years. We are also working with scientists and engineers from the Mount Stromlo Observatory of the Australian National University and the Anglo Australian Observatory in Sydney. Together we have formed JACARA, the Joint Australian Centre for Astrophysical Research in Antarctica. Our research programs take place at two Antarctic Stations; the US Amundsen-Scott South Pole Station, and

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French-Italian Concordia Station, at Dome C in the Australian Antarctic Territory. Our research has been made possible through collaboration with scientists from the USA, Italy and France, together with the active support of the Antarctic programs of those nations. This has provided us with access to Antarctica, as well as all logistics support and accommodation at the Stations. The transportation includes air links, for instance from Christchurch in New Zealand to the South Pole by ski-equipped Hercules, or by Twin Otter from the Italian Terra Nova station to Dome C. It also includes transportation of our equipment, for instance by overland traverse from the French Dumont D'Urville station to Dome C. All transportation has been provided by our partners completely without charge, something we are enormously grateful for. An active and extremely fruitful collaboration has ensued with many scientists from our partner nations.

The aim of our research program is to develop the unmatched potential for conducting astronomical observations of the Cosmos that Antarctica provides over any other site on the Earth. When our program started, in January 1994, it was known that the cold and dry conditions of the Antarctic plateau offered special conditions for making infrared observations, but there had been no quantitative measurements to determine what the performance capability might be. Furthermore, it was also unclear whether the complex equipment necessary for the conduct of astronomical observations could indeed be made to work in the harsh environment of the Antarctic winter, where the temperature might drop to 90 degrees below zero. Our first measurements were made at the South Pole station, and over the past decade we have established the credentials of that site, while developing the technologies to build and operate completely autonomous experiments. During the last two years we have moved to Concordia station, as it nears completion. We conducted the first extensive measurements from that site over the past winter, through completely autonomous experiments. Today, ten years on, it is clear that Antarctica offers many compelling advantages for the future conduct of astronomy.

**The Opportunity for Astronomical Sciences from the Antarctic Plateau**

The Antarctic plateau is the coldest and driest region of our planet. This opens up new windows in the atmosphere through which it is possible to observe the electromagnetic radiation arriving on Earth from space, windows which are closed elsewhere due to the absorption caused by water vapour in the atmosphere. Furthermore, the extreme cold greatly reduces the 'noise' generated by the heat of the atmosphere, significantly improving the sensitivity that an Antarctic telescope can reach compared to placing it at any other ground-based site. Less appreciated is the extreme stability of the atmosphere above the summits of the Antarctic plateau—the wind barely blows at Dome C, in great contrast to the conditions on the Antarctic coast where blizzards are frequent. This dramatically reduces the 'twinkling' of star-light, which otherwise blurs the light gathered from a celestial object. The combination of cold, dry and stable conditions is a potent one—it means a telescope built in Antarctica could detect fainter objects, from further away, and with greater clarity, than the same telescope would be able to achieve from anywhere else on the Earth. Antarctic telescopes are capable of studying the processes that lead to the birth of galaxies, stars and planets in our Universe.

While the potential of Antarctica has been realised for some time, the opportunity to fully utilise it for the conduct of fundamental research in astronomy has only come recently, with the construction of Concordia Station at Dome C, on one of the summits of the Antarctic plateau. This Station will open for winter-time operation in 2005, when the

experiments now underway to quantify the performance capability of the site should also be completed. Based on the data obtained so far, Dome C appears to provide the most superlative site on the Earth for the construction of the next generation of optical and infrared telescopes, the 'extremely large telescopes' with diameters for their primary mirrors from 30m to 100m. The Australian continent lacks any suitable sites for the construction of the current generation of optical telescopes, with the result that Australia's eminent contributions to the astronomical sciences have been declining over the past decade. With the best potential astronomical sites all lying within the Australian Antarctic Territory there is now an opportunity for Australia to play a leading role in what may become one of the great science projects of the 21$^{st}$ century, the construction of the world's largest telescopes. The total investment by the partner nations in such an endeavour will, of course, be significant, running into the hundreds of millions of dollars. Such investment will also provide substantial leverage to any contribution that Australia provides, for not only will the facility be within the Australian Antarctic Territory, all access and support of the Station where the facility is located would have to pass through Australia.

**Funding for Antarctic Research Programs**

We divide our contributions to this section into two parts; funding to support a new program, such as in Antarctic astronomy, and the funding available though the current Antarctic research grant scheme.

1. **Funding for New Research Programs**
   The Antarctic astronomy program our group is pursuing cannot be funded from within the current budget of the Antarctic Division. There is no mechanism within the current budget allocation to allow for such support, however compelling the science may be judged to be. Hence we need to seek support from outside the Antarctic program. Our research has been supported financially almost entirely by the Australian Research Council and capital development grants from the University of New South Wales and the Australian National University, together with the considerable in-kind support from the US, Italian and French national Antarctic programs in providing our logistic needs. Australian Research Council grants, however, can only support research on specific science investigations. They do not provide a means to establish major new facilities, such as those which can support research communities. Herein lies the nexus that the development of Antarctic astronomy has reached within Australia, the lack of a means to provide for the establishment of new facilities in Antarctica.
2. **Antarctic Research Grants Scheme**
   The Antarctic research grant scheme makes available $655,000 yearly for external peer-reviewed research applications, and typically awards grants of between $10,000 and $20,000. While such awards are indeed welcome, they are not capable of supporting research programs by themselves. The facilities and infrastructure needed to conduct the research must already exist. Antarctic research grants typically cover the cost of medicals needed before deployment to Antarctica, and the cost of transportation to the point of embarkation for Antarctica, in our case either Christchurch or Hobart. There is no means through the Antarctic research grants scheme that an externally generated research proposal can establish a new line of investigation outside of the existing infrastructure, or seek the funds necessary to

develop the requisite new infrastructure over a period of time.

**Comment on Air Links**

Air links to and within Antarctica are absolutely essential for the conduct of the best research programs. Air links provide two principle advantages over the current ship-based access. Firstly, they provide ready access to the whole continent, allowing science to be conducted where the returns are judged to be highest. Secondly, they allow rapid access to and departure from experimental sites for scientists. This is essential if senior scientists from outside the Antarctic Division, with other responsibilities at their home institutions, are to be able to take part in research. The Antarctic Division is to be congratulated on its initiative in developing the air link, and it is important for the future flourishing of Australia's Antarctic science program that it be allowed to be fully implemented.

For our own program the existence of air links, both to the South Pole and to Dome C, has been absolutely indispensable for its conduct. It has allowed us to deploy teams scientists three to four times per season for two to three weeks each. Each team has different skills and is able to build on the work of the previous team, and so develop different aspects of the experimental program further. It has allowed senior academics to participate in the research program, alongside their students, with the important training element this brings. It also allows for flexibility in the program, for instance when a piece of equipment fails it is possible to get replacements delivered within a few days, rather than having to postpone work on the program until the next season.

The availability of air links also will bring about a change in the culture of the Antarctic science program. The manner of this change is hard to predict in advance, but the interchanges which will be facilitated between the senior scientists while present in Antarctica, working on quite different projects, will stimulate of new ideas for research programs. Scientists will no longer feel constrained by the places they can readily access, but will be free to consider where the best science can be done, irrespective of location, for air links can provide ready access to all locations. Without doubt the possibilities offered by plateau science stand to gain most by the provision of air links, for Australia has had no ready access to the interior of Antarctica until now. The bulk of the Australian Antarctic Territory consists of the Antarctic plateau, an area of ice largely over 3,000 m elevation. Not only does it provide superb conditions for the conduct of astronomy, it also contains the deepest ice cores for probing climatic change, the largest quantities of pure ice, and the clearest and coldest air on the planet, and sub-surface lakes that are possibly analogous to the oceans on Jupiter's moon Europa, and may contain new varieties of life. Many areas of science stand to benefit by ready access to the Antarctic plateau.

**International Comparisons**

Australia includes the science budget for Antarctica within the overall operations budget of the Antarctic Division. This is in contrast to the Antarctic program conducted by the USA, where the operations and logistics budget are kept separate from that for the science program. The contract for operations is open for bid every few years, and is currently held by Raytheon Polar Services Company. The science budget is managed by the Polar Programs division of the National Science Foundation, and is open for peer-reviewed proposals. The major difference this brings to the US program, which is not available to Australian scientists, is the ability to propose completely new projects, outside the scope of

any which might be currently being conducted. As an example of what this can produce, it has lead to a number of innovative experiments to measure the cosmic microwave background, the relic radiation left over from the Big Bang formation of our Universe. The fact that we live in a flat universe, whose expansion is accelerating, and that the elements we are made of comprise only 4% of the totality of the Universe, is known, to a large part, because of measurements made in Antarctica. Another example of frontier science is that at the South Pole Station two major new research facilities are now under construction. One is a neutrino telescope, and will use one cubic kilometre of ice to build the first detector capable of imaging cosmic sources of this fundamental, but elusive, particle of nature. The second facility is a telescope designed to measure tiny fluctuations in the cosmic microwave background caused by the formation of the first clusters of galaxies in the universe. Both these experiments are conducting investigations in fundamental science, developing new technologies for their implementation, and involving scientists from several nations. They have been driven by the energies of university scientists, and made possible by the process of external peer review as the determining method of allocating the science portion of the Antarctic budget of the partner nations.

**Constraints in Meeting Goals**

The government guidelines allow for the conduct of science within Antarctica, as part of the governance of Australia's territorial claim, as well as its international treaty obligations. However these goals also make it difficult to take up new opportunities within Antarctic science. The goals should not only reflect the importance of undertaking science, but also the criteria of excellence when judging what science should be undertaken. While there is no doubt that Australia conducts excellent science in Antarctica, it is only a subset of what we could be doing. The current government goals lead to the major constraint on developing new initiatives, the limits of the Antarctic research grant scheme. This is the only part of the Antarctic science budget open for external, peer-reviewed proposals. The amount of funding available through this scheme is not sufficient to promote new initiatives. Funding for such initiatives needs to be generated externally, and there is no process by which ventures such as the one we are championing can proceed.

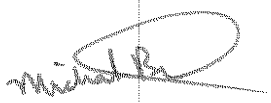
**Capability and Resource Needs**

Australia should become a partner in the new high plateau station of Concordia, at Dome C in the Australian Antarctic Territory. It should become an active player in the science conducted there, including the development of an international observatory, with the goal of participating in the building the ultimate earth-based telescopes for observing the formation of galaxies, stars and planets in the Universe. This goal is well-served by the implementation of air links to and within Antarctica. Australia should seek to capitalise on the establishment of these links to ensure it becomes a major partner in the developments that may ensue. In doing so, Australia will not only reap the technological and scientific benefits that being a part of a major international facility brings, we will also gain the economic benefits through being able to support and supply the infrastructure that ensues.

I would be happy to provide further information to you on any of these points if the

JSCNCET would find that useful.

Thank-you.
Sincerely,



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