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An International Center for Submillimeter Astronomy at Dome C, Antarctica: Statement of Work

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Abstract.
Tests made over the last ten years at various locations show that the Antarctic Plateau is the site with the best observing conditions for ground based astronomical observations at millimeter and submillimeter wavelengths, due to the unique combination of elevation, low atmospheric water vapor content and high atmospheric stability. These characteristics are currently exploited at the Amundsen-Scott Station at the South Pole, where an astronomical facility has been developed mainly for the US astronomical community. It is now time to evaluate the possibility of creating a new Antarctic Center for Millimeter and Sub-millimeter Astrophysics at Dome C, where conditions are expected to be better than at the South Pole, and where the French-Italian Concordia Station is expected to start operations in winter 2004. The station will complement the US South Pole base offering different opportunities to a much wider international community.

Key words. Submillimeter-wave astronomy – telescopes

1. Introduction

We propose the creation of a Working Group (WG) to prepare a strong and compelling scientific and technical case for (sub)millimeter facilities and instrumentation to be built at the Italian-French station of Dome C, on the Antarctic Plateau, where observing conditions are expected to be even better than at South Pole. A progress report of the WG activities will be prepared and presented next July at the

SPS Meeting on Antarctic Astronomy at the IAU2003 General Assembly in Sydney. The WG will include 10 to 15 scientists representing the broadest European and International submillimeter astronomy community interested in the development of the new facility. The proposers listed in this proposal are in representation of a much wider group of scientists and Institutions that have expressed a great interest in this initiative.

After a preliminary period of about 2 months in which Scientists and Institutions interested in the development on the potential of submillimeter astronomy at Dome C will be contacted and informed about the program, the WG will collect and analyze any possible suggestion. In a year the WG will produce a document, supporting or rejecting the creation of the Center, to be eventually submitted to National and International polar and astronomical organizations.

2. Working Group's aims and activities

The main goals of the WG would be:

- Inform the broadest number of Institutions and scientists, in and out of Europe, about the possibilities offered by Dome C for sub(millimeter) astronomy, available site testing data, and expected future capabilities of the Station in order to raise up the vastest interest in the program.
- Investigate how the most recent astrophysical and cosmological questions can be converted into coherent frontier science at (sub)millimeter wavelengths, which would complement and/or expand the scientific goals of other instruments either being built or already planned.
- Determine the optimal optical and mechanical configuration of the instruments, observing strategy, and technical requirements, including novel telescope configurations, in relation to the scientific goals that can be achieved at Dome C (photometry, spectroscopy, polarimetry, interferometry).
- Determine the combined existing facilities and capabilities in theory, data analysis, mm-wave instrumentation and technology of the Institutions, Departments and individual members that will be participating in the effort, and that are needed to implement an aggressive scientific program.
- Determine the advantages and drawbacks of a (sub)millimeter facility in Antarctica, in the expected wavelength range of operation, as compared to other potential sites having different precipitable water vapor, atmospheric stability, and sky coverage.
- Identify the technological achievements for the realization of a facility designed to withstand the harsh environmental conditions of the Antarctic Plateau winter.
- Propose further dedicated site testing studies at Dome C and collaborate to their development.
- Investigate, in cooperation with the Italian and French Antarctic Programs (that will be asked to appoint an intermediary to the WG) the logistic requirements for the realization and the operation of the facilities, including:
  - instrument shipping, including cryogenic liquids, and storage
  - in situ logistic support (mechanical workshop, electronic workshop and instrumentation, personnel requirement for winter)
  - data communications and instrument control
  - electrical power
- Investigate about the use of Concordia station as a workbench for the development of automated and robotized instrumentation to be deployed at other unmanned sites in the Antarctic Plateau, e.g. Dome Argus.
- Investigate potential collaborations with Institutions interested in exploiting the site for testing space- or

balloon-borne technology, in order to plan a reliable and cost-effective instrumentation. Special attention should be devoted to determine whether the project would be able to get access to state-of-the-art detector arrays technology. The WG will also prepare a preliminary budget and will contact the national and international agencies that may allocate the necessary funds.

Particular care will be dedicated to the development of links with other organizations involved in the development of Antarctic Astronomy, and with other Antarctic Programs or Organizations (SCAR) that could potentially supply useful logistic support. We stress that the results of the WG will be of general interest for other science programs. It will take a wide range of different skills and resources to achieve the technical and scientific goals of this project, and an International Center is the best option for combining novel technologies, observing methods and data analysis and interpretation. The potential scientific payoff is so high that a European and International perspective and effort are required to fully reap the benefits, while ensuring a reliable facility and modes of operation and access to the international astronomical community.

3. Scientific Rationale

A number of very exciting recent high sensitivity experiments at millimeter and submillimeter wavelengths, such as BOOMERanG, MAP and MAXIMA, have clearly shown what may be learned from the CMB anisotropy at an angular resolution better than 0.2°. New facilities coming on line in the next few years, such as BLAST, LMT and ALMA, are expected to give fundamental contributions in interpreting the nature of the faint submillimeter galaxies and in the field of low- and high-mass star formation. Experiments aimed to measuring the CMB polarization anisotropy are also being planned, which promise to test inflation and measure when reionization occurred. To summarize, the main scientific areas which are likely to experience a rapid theoretical and observational development at millimeter and submillimeter wavelengths during the next decade or so are:

- the anisotropy and polarization of the CMB;
- the inflationary Universe;
- the origin and evolution of (star forming) (proto)galaxies;
- the molecular ISM in the galaxy and star formation.

Research in these and other similar fields will attempt to answer several fundamental questions regarding the origin and evolution of galaxies and stars. In particular:

- What is the origin of the submm/FIR background?
- How dusty galaxies evolve?
- How can (sub)mm redshifts improve constraints on evolution?
- When did stars form and what is the SF history of the Universe?
- How do self-gravitating dense cores form from the ISM and how are protostar condensations distributed in molecular clouds?
- What are the lifetimes of ultracompact HII regions and how do high-mass stars form?

While considering the schedule and goals of the project, the WG should take into account the impact that near-future experiment (e.g., BLAST, CBI, APEX, etc.) will have in the field and the potential of this project to also serve as pathfinder for future ground (e.g., LMT, ALMA) and (sub)orbital (e.g. Herschel, Planck, etc.) instruments.