ANTARCTIC OBSERVATIONS OF THE COSMIC MICROWAVE BACKGROUND

George F Smoot
Lawrence Berkeley Laboratory

In the standard cosmology of the Big Bang theory the cosmic microwave background (CMB) is the remnant radiation from the hot early universe. The sky signal is comprised of radiation from the CMB, from Galactic emission, from atmospheric emission, and from instrument sidelobes seeing the ground and man-made interference. One observes in directions of minimum galactic signal. The antarctic polar plateau provides the best site in the world for low atmospheric emission, low horizons, low man-made interference, and reasonable accessibility. The low column density of precipitable water and extreme stability for periods exceeding a week, combined with low RFI are critical. A very important secondary benefit for anisotropy experiments is the ability to observe the same part of the sky continuously at a high elevation angle.

Attention was drawn to Antarctica as the place to make CMB observations in the early 1980s due to reports of measurements of low atmospheric emission and variability at South Pole (by Puget *et al.*) and at the Soviet station, Vostok (by Burzkaza *et al.*). Subsequently, several groups in the United States (Dragovan *et al.*, Bell Labs; Peterson *et al.*, Princeton; Lubin *et al.,* UC Santa Barbara; Smoot *et al.*, UC Berkeley) and from Italy (Dall'Oglio *et al.* Roma; Sironi *et al.* Milano) began programs of CMB observations from Antarctica. All but one were from the South Pole.

On medium angular scales the best observations have been made from the South Pole ground-based site (Dragovan *et al.*, Peterson *et al.*, and Lubin *et al.*) and by balloon-borne instruments. Meinhold and Lubin have currently published the best results and have shown that the South Pole and the high Antarctic plateau are particularly attractive sites. CMB observations are a significant portion of the research proposed for the new Center for Astrophysical Research in Antarctica (CARA). The Meinhold and Lubin observations resulted in a limit on the astrophysical anisotropy of $\Delta T/T < 3.5\times10^{-5}$ at the 95% C.L. at an angular scale of about 1/2 degree. This results in a severe constraint for the Cold Dark Matter model of galaxy formation (Vittorio *et al;* Bond *et al.*).

A Berkeley and Milano collaboration have made low-frequency spectral measurements of the CMB from the South Pole. In the austral summer of 1989 the collaboration took six radiometers to the CMB site about 1.5 km from the Amundsen-Scott South Pole Station. Extensive observations were made at wavelengths of 0.3, 4, 8, 12, 20 and 30 cm complementing the shorter-wavelength observations of the *COBE*-FIRAS experiment (Mather *et al.* 1990). The observations confirm the blackbody spectrum over this long-wavelength range (Sironi *et al.* De Amici *et al.*, Smoot *et al.*) to the few per cent level.

Those data plus the *COBE* data limit the shape and amplitude of possible spectral distortions and restrict the energy release in the early universe (one month onward or $10^3 < z < few \times 10^6$) to less than about 0.5% of the energy in the CMB. This in turn limits various models of galaxy formation and clustering as well as things like primeval turbulence, primordial particle decay etc (Smoot *et al.*).

We anticipate that these experiments, CARA, and new experiments and international observatories will make Antarctica an active site of CMB measurements in the coming years.