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A two band far-infrared photometer with bolometer arrays

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Abstract. A new two band photometer for the TIFR 1m balloon-borne telescope has been described. The detector system consists of two arrays (of six detectors each) of liquid ^{3}He cooled bolometers. The two bands have effective wavelengths of 130 and 200 μm.

Key words : far-infrared photometer—infrared mapping

At the Tata Institute of Fundamental Research (TIFR) we have been using a 100 cm balloon-borne telescope for far-infrared mapping of Galactic star forming regions and external galaxies. In order to improve the sensitivity and efficiency of this telescope, a new two band photometer has been fabricated. This photometer will simultaneously view the sky in two far-infrared bands centered at ~ 130 and 200 μm.

The schematic diagram of the photometer is shown in figure 1. The detector system consists of two arrays of composite Silicon bolometers, each array having six (1 mm × 1 mm) bolometers arranged in a grid of 3 × 2. The bolometers are cooled to a temperature of ~ 0.3 K using liquid ^{3}He, condensed by a closed cycle charcoal pump refrigerator. The bolometers have NEP (noise equivalent power) of ~ 10^{-15} W Hz$^{-1/2}$, thermal conductivity of 10^{-7} W/K and responsivity of 10^7 V/W. The bolometers are placed at the exit apertures of Winston cone light collectors having entrance apertures of 0.4 cm and field of view of f/6. The entrance aperture of 0.4 cm corresponds to 1.6 arc min. for the 1m telescope.

The two photometric bands are separated by the use of a cool reststrahlen filter of CsI (later to be replaced by an interference filter). There is a KCl filter in front of the short wavelength channel bolometers and a quartz filter with garnet in front of the long wavelength channel. The thermal input, due to the radiation at shorter wavelengths, is minimised by the use of several quartz filters (at ambient temperature, at 77 K and at 4 K) with diamond powder coating. The peak transmissions in each band are ~ 45% and the effective wavelengths for the two bands are ~ 130 μm and 200 μm. These wavelength bands are beyond the wavelength range covered by the IRAS satellite and are optimized for the study of cool sources (T ≤ 30 K).

Bolometer signals are amplified using a low noise (~ 6 nV Hz$^{-1/2}$) 12 channel preamplifier, attached to the body of the cryostat, before going to the main electronic processing unit of the telescope. The gain of the preamplifier is 300 for the short wavelength channels and

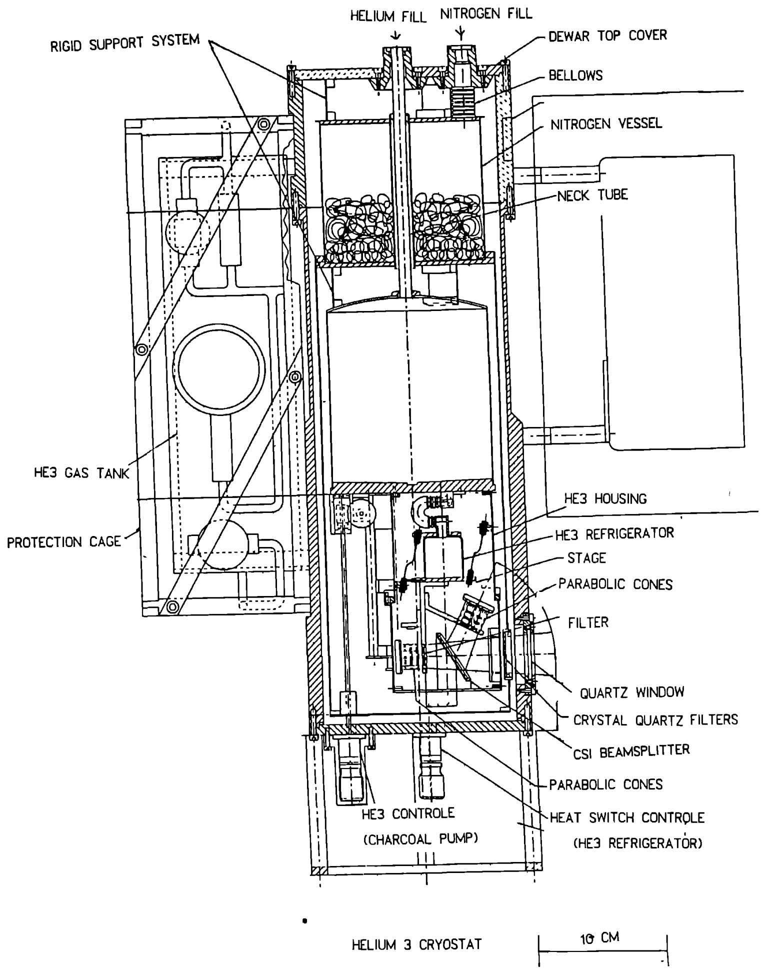

Figure 1. The schematic diagram of the photometer.

1000 for the long wavelength channels. The first stage of the preamplifier uses cold (~ 80 K) JFETs to avoid pick up noise.

With this new photometer the time required to map a given area in the sky is reduced by a factor of 3-4 as compared to the earlier photometer with one detector for each channel. Also, the sensitivities of the bolometers are higher by a factor of 3-4. This photometer will be used in the forthcoming balloon flight of the 1m telescope. We should be able to achieve a NEFD (noise equivalent flux density) of 10-15 Jy $Hz^{-1/2}$ and a (1σ) sensitivity of a few Jy in the deconvolved map.