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FINAL REPORT
NAGW-4623

"SPACE-BORNE INFRARED ASTRONOMY"

Funds from this grant were used to develop the Far IR Photometer (FIRP), one of four focal plane instruments on the IR Telescope in Space (IRTS). The IRTS was successfully launched in March 18, 1995 aboard the Japanese SFU platform. It surveyed the IR sky for approximately 40 days, and was eventually retrieved by NASA's STS.

The FIRP succeeded in surveying approximately 5% of the sky in four bands centered at 150, 250, 400 and 700 microns. Several new technologies were developed using the funds from this grant, including: (1) a high performance gas-gap heat-switch, (2) a ^3He sorption refrigerator that is, to date, the only refrigerator to achieve sub-Kelvin temperatures in orbit, (3) high-sensitivity bolometric detectors with $\text{NEP} < 10^{-16} \text{ W}\sqrt{\text{Hz}}^{1/2}$ when operated from a 300 mK heat sink, (4) readout electronics capable of providing DC stability for the bolometric detectors.

Excess noise of unknown origin significantly reduced the sensitivity of the FIRP on orbit. Nevertheless, scientifically significant observations of the spectrum and temperature of the interstellar dust were made, and have been reported in Hirao et al. (1996).

A full list of publications resulting from the FIRP program is given below.

1. F.M. Rieke, A.E. Lange, J.W. Beeman, and E.E. Haller, "An AC Bridge Readout for Bolometric Detectors", *IEEE Trans. Nuclear Science*, 36, 946 (1989).
2. L. Duband, L. Hui, and A. Lange, "A Space-borne ^3He Refrigerator", *Cryogenics*, 30, 263 (1990).
3. T. Wilbanks, M. Devlin, A.E. Lange, S. Sato, J. W. Beeman, and E.E. Haller, "Improved Low Frequency Stability of Bolometric Detectors", *IEEE Trans. Nuclear Science*, 37, 566 (1990).
4. M. Devlin, A.E. Lange, T. Wilbanks, and S. Sato, "A DC-Coupled, High Sensitivity Bolometric Detector System for the Infrared Telescope in Space", *IEEE Trans. Nuclear Science*, 40, 162 (1993).
5. L. Duband, L. Hui, and A. Lange, "Thermal Isolation of Large Loads at Low Temperature using Kevlar Rope", *Cryogenics*, 33, 643 (1993).

6. M.M. Freund, T. Hirao, T. Matsumoto, S. Sato, T. Watabe, G.K. Brubaker, L. Duband, B. Grossman, N. Larkin, S. Lumetta, and A.E. Lange, "A Far Infrared Photometer (FIRP) for the Infrared Telescope in Space (IRTS)", *Adv. Space Res.*, 13, (12)505 (1993).
7. A.E. Lange, M.M. Freund, S. Sato, T. Hirao, T. Matsumoto, and T. Watabe, "The Far-Infrared Photometer on the Infrared Telescope in Space", *Astrophys J.*, 428, 384 (1994).
8. H. Murakami, J. Bock, M. Freund, H. Guo, T. Hirao, A.E. Lange, H. Matsuhara, T. Matsumoto, S. Matsuura, T.J. McMahon, M. Murakami, T. Nakagawa, M. Noda, K. Noguchi, H. Okuda, K. Okumura, T. Onaka, T.L. Roellig, S. Sato, H. Shibai, T. Tanabe, T. Watabe, T. Yagi, N. Yajima, and M. Yui, "The Infrared Telescope in Space (IRTS)", *Astrophys. J.*, 428, 354 (1994).
9. J. Bock, A.E. Lange, H. Matsuhara, T. Matsumoto, T. Onaka, and S. Sato, "Cooled Baffle System for Spaceborne Infrared Telescopes", *Appl. Opt.*, 34, 2268 (1995).
10. M.M. Freund, T. Hirao, V. Hristov, S. Chegwiddden, and A.E. Lange, "Compact Low-Pass Electrical Filters for Cryogenic Detectors", *Rev. Sci. Instr.*, 66, 2638 (1995).
11. J.J. Bock and A.E. Lange, "Performance of a Low-Pass Filter for Far-Infrared Wavelengths", *Appl. Opt.*, 34, 7254 (1995).
12. H. Murakami, M.M. Freund, K. Ganga, H. Guo, T. Hirao, N. Hiromoto, M. Kawada, A.E. Lange, S. Makiuti, H. Matsuhara, T. Matsumoto, S. Matsuura, M. Murakami, T. Onaka, T. Nakagawa, M. Narita, M. Noda, H. Okuda, K. Okumura, T. Onaka, T.L. Roellig, S. Sato, H. Shibai, B.J. Smith, T. Tanabé, M. Tanaka, T. Watabe, I. Yamamura, and L. Yuen, "The IRTS (Infrared Telescope in Space) Mission", *Pub. Astron. Soc. Japan*, 48, L41 (1996).
13. T. Hirao, T. Matsumoto, S. Sato, K. Ganga, A.E. Lange, B.J. Smith, and M.M. Freund, "Submillimeter Observations of the Galactic Plane by the IRTS", *Pub. Astron. Soc. Japan*, 48, L77 (1996).
14. L. Duband, A. Lange, J. Bock, "Helium Adsorption Coolers for Space", *30th ESLAB Symposium*, ESA SP-388, 289 (1996).
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