Design and Performance of Micro-Spec, an Ultra Compact High-Sensitivity Far-Infrared Spectrometer for SPICA

220TH AAS Meeting (Anchorage, AK)

Giuseppe Cataldo[1,2], S. H. Moseley[1], W.-T. Hsieh[1], W.-C. Huang[1], T. R. Stevenson[1], E. J. Wollack[1]

[1]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA
[2]USRA – Universities Space Research Association, Columbia, MD, USA

ABSTRACT

Micro-Spec (μ-Spec) is a high-performance spectrometer working in the 250-700-μm wavelength range, whose modules use low-loss superconducting microstrip transmission lines on a single 4-inch-diameter silicon wafer. Creating the required phase delays in transmission lines rather than free space allows such an instrument to have, in principle, the performance of a meter-scale grating spectrometer. Such a dramatic size reduction enables classes of instruments for space that would be impossible with conventional technologies. This technology can dramatically enhance the long-wavelength capability of the space infrared telescope for cosmology and astrophysics SPICA.

μ-Spec is analogous to a grating spectrometer. The phase retardation generated by the reflection from the grating grooves is instead produced by propagation through a transmission line. The power received by a broadband antenna is progressively divided by binary microstrip power dividers, and the required phase delays are generated by different lengths of microstrip transmission lines. By arranging these outputs along a circular focal surface, the analog of a Rowland spectrometer can be created.

The procedure to optimize the Micro-Spec design is based on the stigmatization and minimization of the light path function in a two-dimensional bounded region, which results in an optimized geometry arrangement with three stigmatic points. In addition, in order to optimize the overall efficiency of the instrument, the emitters are directed to the center of the focal surface. The electric field amplitude and phase as well as the power transmitted and absorbed throughout the region are analyzed. Measurements are planned in late summer to validate the designs.

This material is based upon work supported by NASA through the ROSES/APRA program. This research was supported by an appointment (Cataldo) at the Goddard Space Flight Center administered by Universities Space Research Association through a contract with NASA.

Plain language: This work presents the design and performance of μ-Spec, a compact instrument for the space infrared astronomy and cosmology. It can significantly enhance the capability of the Japanese SPICA mission. Its high sensitivity in the far infrared will revolutionize our understanding of the distant universe.