The SAFARI far-IR Spectrometer for SPICA

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The Space Infrared telescope for Cosmology and Astrophysics (SPICA) [1] is a joint space mission (Fig. 1) of the European Space Agency (ESA) and the Japanese Space Agency (JAXA), currently under study in ESA's M5 programme [2,3]. One of the proposed instruments is the SAFARI far-IR spectrometer providing low (R ≈ 300) to medium (R up to 11000) resolution spectroscopy across 4 detector bands simultaneously covering the 34-230 μm wavelength band. Taking full advantage of a 2.5m cryogenic telescope, actively cooled to below 8K, SAFARI will offer unprecedented spectroscopic sensitivity closing the gap between JWST-MIRI and ALMA.

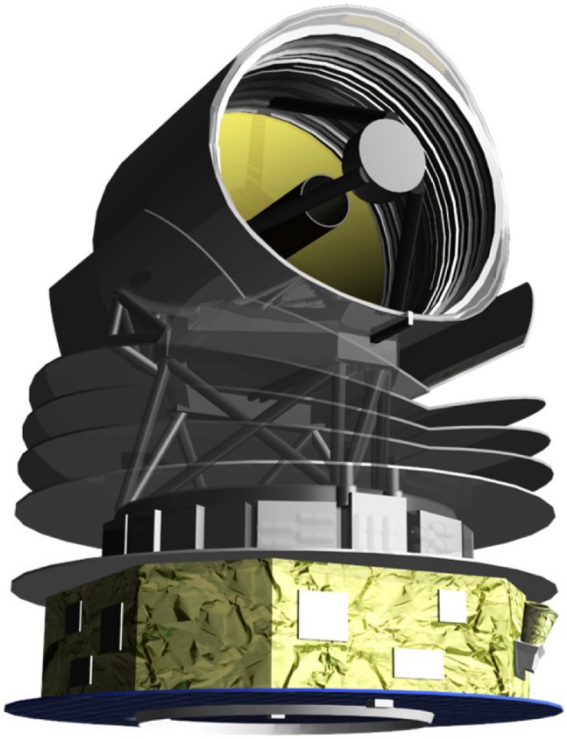

Fig. 1. The SPICA space observatory (JAXA/ESA/SPICA).

The instrument architecture of SAFARI is based on a cryogenic post-dispersed polarizing Martin-Puplett (MP) Fourier Transform Spectrometer (FTS) scheme, and 4 low-resolution grating spectrometer modules, employing horn-coupled TES detector arrays. The Transition-Edge Sensor (TES) detectors, cooled to about 50 mK by a Adiabatic Demagnetization Refrigerator (ADR) cryocooler, are combined with a Frequency Domain Multiplexed (FDM) readout system, and yield a detector system NEP of order 2×10^{-19} W/√Hz corresponding to a limiting line flux of about 5×10^{-20} W/m^2 (5σ-1hr).

In this paper we will provide an overview of the instrument design and its current state of development. We will present the optical design of the instrument, with a particular emphasis on the overall spatial multiplex and band division scheme, an 8x folded MP interferometer layout, and compact grating spectrometer modules. We also show recent results obtained in the key technology areas: the cryogenic FTS scan mechanism, the TES + FDM detector system and sub-Kelvin cryocooler. We conclude our paper by summarizing the expected performance metrics of the instrument.

References

[1] P.R. Roelfsema et al, "SPICA—A Large Cryogenic Infrared Space Telescope: Unveiling the Obscured Universe," *Publications of the Astronomical Society of Australia*, vol. 35, Aug.2018, 10.1017/pasa.2018.15

[2] https://spica-mission.org/spica-mission.org/version2/wp-content/uploads/2019/06/SPICA-M5-Proposal-V1.1.pdf

[3] https://spica-mission.org

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