The SAFARI grating spectrometer for SPICA

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Abstract— The far-infrared spectrograph SAFARI, on the joint European-Japanese space telescope SPICA (proposed in the ESA M5 Call), will provide the most sensitive view ever of the cool, obscured universe. By cooling the SPICA telescope to below 8 K its thermal emission is decreased to such low levels that the latest generation of ultra-sensitive Transition Edge Sensor (TES) detectors can be utilized to their full potential. With this combination of low background and extreme detector sensitivity SPICA will be able to look far deeper into space than was possible with any of its predecessors. SPICA/SAFARI is the only facility that will fill the gap in the wavelength domain between the other great observatories, and is as sensitive as both the James Webb Space telescope and the ALMA radio observatory – only with SPICA/SAFARI we will complete the view on the star-formation history of our universe.

The current baseline SAFARI design uses a beam steering mirror (BSM) that forwards the incoming signal to the dispersing and detection optics. The BSM is used to select sky or calibration signals and forward that to a nominal R~300 (low) resolution optics chain or to a R~11000 (high) resolution optics chain. The low resolution is obtained by dispersion through a diffraction grating illuminating a line of TES detectors. For the high-resolution mode, the signal is first pre-dispersed using a Martin-Puplett interferometer before entering the grating. The full 35-230 μm wavelength range is split in to several different bands, each with its own grating and TES detectors. The baseline design has for each of the bands three separate spatial pixels, to provide background reference measurements, but also to provide some imaging capability.

With SPICA's cold, 2.5-meter telescope and the baseline TES NEP of $2x10^{-19}$ W/ √Hz, for the new grating based SAFARI the sensitivity of the R~300 mode will be about 5 x 10^{-20} W/m^2 (5 σ , 1hr). With this high sensitivity astronomers will e.g. be able to detect the [OIV] line in relatively average galaxies out to a redshift z~3. Thus, the evolution of galaxies can be followed through their most active periods in cosmic time from about 10 billion years ago to what they look like today. Additionally, we will be able to observe dust features from even earlier epochs, out to redshifts of z~7-8, thus providing insight into dust formation in the very early phases of the universe.