# The Single-Aperture Far-Infrared Observatory (SAFIR): Scientific Promise, Mission Concepts, and Technical Implementation

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The Single Aperture Far Infrared (SAFIR) telescope facility is proposed as NASA's next major far-IR astrophysics mission, envisioned for the 2020 decade. SAFIR will operate at wavelengths from 20 microns to 1 mm, a regime inaccessible to ground-based telescopes but critical for fundamental questions. The cosmic background spectrum measured with COBE shows that half of the energy ever released in the history of stars and galaxies is in the far-IR / submillimeter – most likely due to dust-obscured stars and accretion. SAFIR will enable study of this far-IR half of the universe on all scales, from the earliest dusty galaxies to local galaxies and the Milky Way.

SAFIR will provide huge increases in sensitivity by combining a large ($\sim$10-meter), cold (T $<$ 5 K) telescope with efficient, high-throughput instruments and very sensitive detectors. The result will be a system that approaches fundamental measurement limits – photon noise from zodiacal and galactic cirrus backgrounds. With array formats of 10^4-10^5 elements, continuum mapping with SAFIR will be very rapid, on order a square degree per day to 10 micro-Jy RMS at 100-300 microns, resolving the cosmic far-IR background into its constituent galaxies over hundreds of square degrees. For follow-up of these galaxies, sensitive R$\sim$1000 spectroscopy will be a prime goal of SAFIR, with 1-hour line sensitivities (5-sigma) on order 10^-21 W m^-2. This will be sufficient to measure bright far-IR fine-structure diagnostics in even modest (10^11 L_solar) galaxies to redshift 5, and will enable detailed studies of embedded processes in more local galaxies.

SAFIR's approach and technologies will derive from many sources. For detectors and instruments, NASA's success with Spitzer and its contributions to Herschel, Planck, and ground-based instruments will lead the way. For the large deployed sunshade architecture, the JWST development will provide a benchmark. While most of the key technologies are or will be available, the greatest challenge remais developing robust detectors in large arrays sufficiently sensitive to take advantage of

the low-background environment. We review recent progress which is encouraging and suggests that the requirements for SAFIR will be met on its timescale.