Opportunity Title: Studying the Reionization Epoch with Superconducting On-Chip Spectroscopy
Opportunity Reference Code: 0232-NPP-NOV23-JPL-Astrophys

Organization National Aeronautics and Space Administration (NASA)

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Application Deadline 11/1/2023 6:00:59 PM Eastern Time Zone

Description The Reionization epoch, when the ensemble of young galaxies produce sufficient hydrogen-ionizing photons to change the state of the intergalactic gas is a complex and incompletely understood period in cosmic history. The process has star formation at its core, but additional factors such as the UV photon escape fraction and recombination rates are important. Line intensity mapping (LIM) in far-IR through millimeter waveband is an emerging technique to study this epoch in a manner complementary to galaxy surveys. By using the Fourier-domain clustering signal imprinted by the structure of the Universe, LIM measures all the light emitted in a given epoch, regardless of whether it originates from many faint sources or a few bright ones. This is a powerful attribute since this period is believed to be dominated by low-luminosity galaxies. LIM using the fine-structure transitions such as the 158-micron [CII] transition can provide an initial constraint on the total star formation activity, while future measurements of other higher-frequency lines can both refine this estimate and provide insights into stellar populations and early black holes, heavy element production, and feedback / regulation at these early times.

We are developing instruments for this type of measurement from ground-based, balloon-borne and space-borne platforms throughout the far-IR to millimeter band. They require moderate-resolving power, but large-format field-filling spectrometers, with large arrays of background-limited detectors. To overcome the size limitations of classical grating spectrometers (particularly limiting in the millimeter band), we have pioneered a superconducting integrated circuit spectrometer SuperSpec; which combines a millimeter-wave filterbank with an integrated kinetic inductance detector array on a small (few square-centimeter) silicon chip. We are beginning a demonstration campaign with a small instrument housing six SuperSpec spectrometer chips at the Large Millimeter Telescope (LMT), this is primarily for galaxy by galaxy follow-up. Meanwhile, we are now planning for a much larger, dedicated millimeter-wave intensity mapping instrument for a low-background terrestrial site.

We are seeking a postdoctoral fellow to join the group and push these measurements forward. Opportunities include participating in the LMT campaigns coming underway soon, but we envision a fellow‘s primary thrust as building on the SuperSpec architecture to create the next-generation focal plane which carries ~100 or more spectrometer pixels. The fellow would have an opportunity to play a leading role in a collaboration to field and use this new instrument.

If desired, the fellow will also have the opportunity to contribute to the development of ultra-sensitive far-IR detectors for space-borne platforms, as well as our integration and fielding of the Terahertz Intensity Mapper (TIM) balloon-borne spectrometer.

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References:

Hailey-Dunsheath, S., Shirokoff, E., et al., 2014. ""Status of SuperSpec: a broadband, on-chip millimeter-wave spectrometer,"" Proceedings of the SPIE, v. 9153, ID 91530M.

Shirokoff, E. et al., 2014, ""Design and Performance of SuperSpec: An On-Chip KID-Based, mm-Wavelength Spectrometer,"" Journal of Low Temperature Physics, v. 176, 657-662.

Redford, J. et al, 2018. The design and characterization of a 300 channel, optimized full-band millimeter filterbank for science with SuperSpec, Proc. SPIE, 10708, 107081O.

Wheeler, J. et al, 2016. SuperSpec: development towards a full-scale filter bank. Proc. SPIE, 9914, 99143K.

Location:
Jet Propulsion Laboratory
Pasadena, California

Field of Science: Astrophysics

Advisors:
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Applications with citizens from Designated Countries will not be accepted at this time, unless they are Legal Permanent Residents of the United States. A complete list of Designated Countries can be found at: https://www.nasa.gov/oiir/export-control.

Eligibility is currently open to:

- U.S. Citizens;
- U.S. Lawful Permanent Residents (LPR);
- Foreign Nationals eligible for an Exchange Visitor J-1 visa status; and,
- Applicants for LPR, asylees, or refugees in the U.S. at the time of application with 1) a valid EAD card and 2) I-485 or I-589 forms in pending status

Eligibility Requirements

- **Degree:** Doctoral Degree.