NASA SBIR Select 2014 Phase I Solicitation

S20.02 Novel Spectroscopy Technology and Instrumentation

Lead Center: GSFC

Participating Center(s): JPL

In astrophysics, science instruments are â€œphoton starvedâ€. Every photon has to count. Efficient use of light and maximizing signal-to-noise is critical and there is always room for improvement. In many high-resolution spectroscopy systems as much as 50% of the light is lost in the spectrometer optics before it gets to the detectors. It is far more cost-efficient to improve detection systems in terms of throughput, efficiency, resolution, and noise than to compensate by making the payload larger. Spectroscopy is applicable in the UV, visible, IR. In terms of instrumentation, answers to higher photon efficiency can be answered through entire novel instrument (system designs) to single components (filters, grisms, gratings, etc.)

Transit Spectroscopy, multi-object spectrographs, slit and slit-less spectrographs and associated component and subsystem technologies such as grisms, filters, etalons, etc. enable higher performance and more efficient use of the light collected. High-resolution spectroscopy for galaxy evolution, exoplanet spectroscopy for deciphering the chemical composition of exoplanetary atmospheres. High resolution spectroscopy in UV, Visible, and IR.

Specific areas of research include:

- Image slicers. Imager slicers are stacks of optics that `slice' a field into separate regions and remap them into a pseudo-slit (or slits) that are then fed into a traditional spectrograph. This design can be used to produce an efficient imaging spectrograph that has a high fill factor. Micromirror and lenslet-based integral field spectrographs have a very low fill factor by comparison (less efficient use of pixels by a factor of 4).
- Micromirror arrays. Micromirror arrays work similarly to lenslet arrays in that they compress the light from a single spatial location into a focused spot. UV wavelengths however require micromirror arrays because refractive optics will not work. In addition, micromirror arrays can operate over broad bandpasses without producing chromatic aberrations.
- Improved dichroic filters. Dichroic filters reflect a certain bandpass and transmit another wavelength. Improved dichroic filters would enable more efficient use of separate science instruments or a single multi-band imaging instrument.
- Lenslet-coupled fiber optics for space flight. Fiber-fed lenslet arrays could also be used to produce a pseudo-slit in a similar way to the image slicers. The fiber-coupling losses and problems with packing the fibers closely due to the cladding have precluded their use.
- Improved Fabry Perot etalons. Fabry Perot etalons are some of the highest resolution spectrometers that are used for instrumentation but they suffer from high loss and large size that make them difficult to implement for space. Improvements in size and efficiency are sought for Fabry Perot etalons.
- Improved gratings.
- On chip hyperspectral imaging systems. Hyperspectral imaging is an area of continued interest in particular to Earth Science for applications such as agriculture and land use. These systems tend to be complex and

difficult to implement. Approaches to integrate the hyperspectral filtering with the detector are sought.