THE ORIGINS SURVEY SPECTROMETER (OSS) FOR THE ORIGINS SPACE TELESCOPE: ENABLING UNBIASED SPECTRAL SURVEYS OF GALAXIES THROUGH COSMIC TIME.

C.M. Bradford[1] and the OSS / Origins team[2], [1]Caltech / JPL, Pasadena, CA, USA

Introduction: The Origins Survey Spectrometer (OSS) is a multi-purpose wideband spectrograph for the Origins Space Telescope. The sensitivity possible with the combination of the actively-cooled 5.6-meter OST telescope and new-generation far-IR direct detector arrays is outstanding; offering the potential for 100,000x improvement in speed over Herschel and SOFIA for point-source measurements, and factor of more than 1,000,000 for spatial-spectral mapping. Massive galaxy detection rates are expected in the rest-frame mid- and far-IR spectral lines, overcoming continuum confusion and reaching back to the epoch of reionization.

OSS Core--6 Grating Bands: The OSS covers the full 25 to 585 μm band instantaneously at a resolving power ($R = \lambda/\delta\lambda$) of 300 using 6 logarithmically-spaced grating spectrometer modules. Each module couples a long slit with at least 30 and up to 100 spatial beams simultaneously. Each slit is 1 beam wide, and they range in length from 2.7 to 14 arcminutes in length, enabling true 3-D spectral mapping, both for the blind extragalactic surveys and for mapping all phases of interstellar matter in the Milky Way and nearby galaxies (Figure below, right). Through the use of dichroics and polarizing filters in the grating feed optics, the slits are co-aligned so that a point source centered in the short-wavelength slit simultaneously couples to all 5 other bands for maximum efficiency in obtaining full-band spectra of targets of interest (Figure below, left).

High-Resolution Modes: Two high-resolution modes are provided, also using the grating modules and their arrays as the detector. The first inserts a long-path Fourier-transform interferometer similar to that used in Herschel SPIRE into the light path in advance of the grating backends. The path-folding polarizing FTS provides resolving power R up to 38,000 x [100μm / λ], while preserving the grating-based sensitivity for line detection. The second incorporates a scanning etalon to provide R up to 300,000 for the 100-200 μm range for velocity-resolved tomography in protoplanetary disks using the ground-state transitions HD and water.

Detectors for OSS: OSS requires large arrays of direct detectors with the per-pixel sensitivity meeting or exceeding the photon background limit of the zodiacal and Galactic dust. The noise equivalent power (NEP) requirement is 3e-20 W/sqrt(Hz), and sensitivities approaching these levels have been demonstrated in few-pixel prototypes. The total pixel count for all 6 OSS arrays is ~60,000 pixels, and multiple readout systems supporting these numbers have been demonstrated. These sensitive far-IR arrays and their readouts are not provided by the kind of industrial efforts producing the optical and near-IR detectors; they are being developed by the science community, including OST team members. We review the rapid progress in this area and prospects for demonstrating flight readiness (TRL 6) on Origins timescale (mid 2020s).

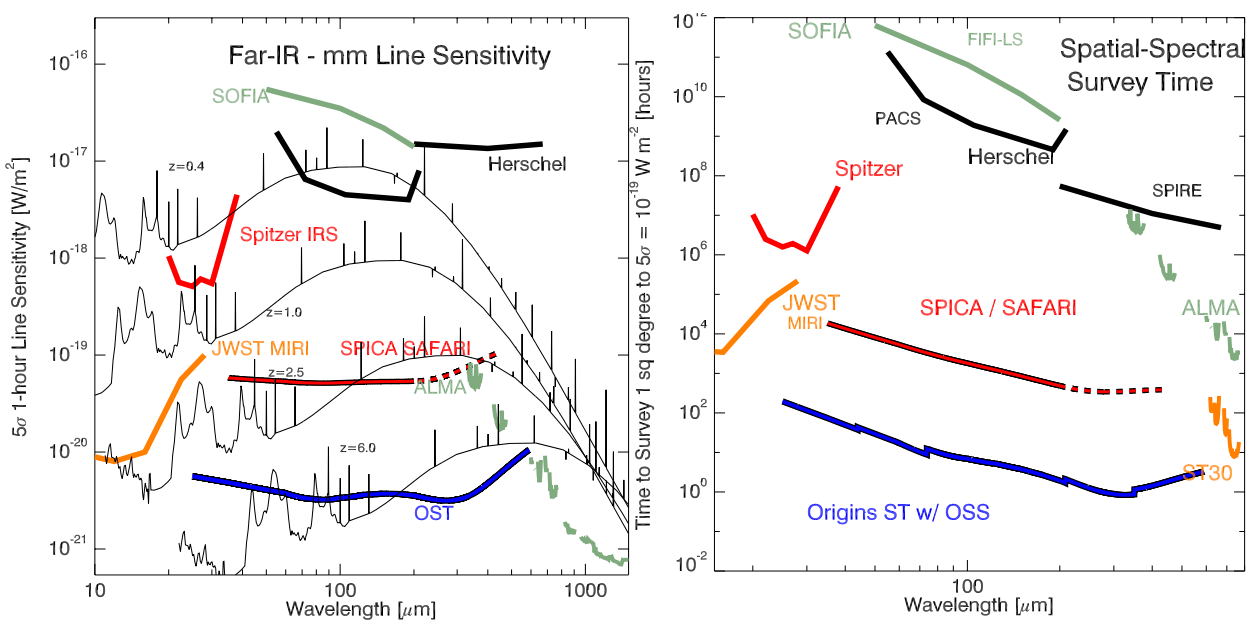

Figure 1 LEFT: Point-source spectral line sensitivity; OSS provides instantaneous full-band coverage. RIGHT: Time metric for blind field-filling full-band spatial-spectral surveys, a key mode for Origins extragalactic science. Note vertical axis range.