EXES: Echelon-Cross-Echelle Spectrograph

Principal Investigator Class, High Res, Mid-Infrared Spectrograph

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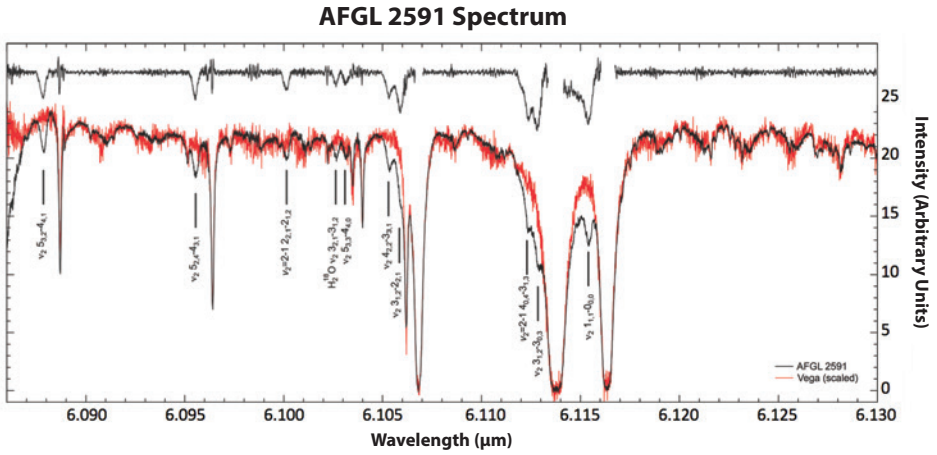
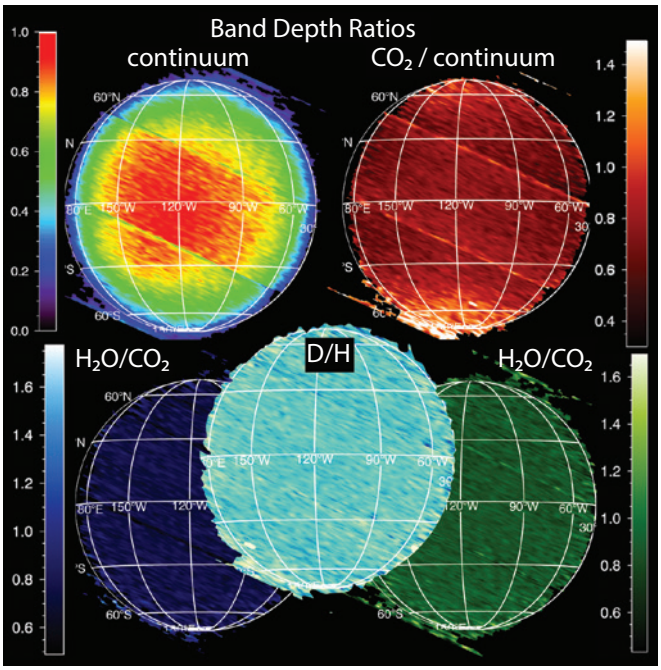
Spectrally Resolved H_2O Absorption Lines



On its second commissioning flight, EXES generated a high resolution spectrum (R=80,000, 4 km/s) revealing gas phase H_2O lines toward the massive Young Stellar Object AFGL 2591. Shown in the figure below are the spectrum of AFGL 2591 (black trace), telluric standard (red trace), and the residual after telluric and baseline correction *(top)*. The transition near 6.115 μm is that of absorption by para-H_2O in the ground state, Doppler shifted by ~40 km/s from the deep telluric feature at the time of the observations. The EXES observations resolve the H_2O lines for the first time. The line width of 15 km/s locates the gas at the base of the molecular outflow. *(Indriolo et al., 2015, ApJL, 802, 14.)*

Venus Spectral Maps

EXES observed Venus with high spectral resolution at 7.2 μm, simultaneously probing the amount of water and (semi) heavy water in its clouds. Relating the D/H ratio to clouds, temperature, global position, and seasons helps to constrain the microphysical models of water-loss used to study the evolution of Venus's atmosphere. Preliminary results show a surprising spatial uniformity to the D/H ratio. Ratio to the CO_2 strength allows us to cancel, to first order, the effects associated with the calibration, the geometry, and atmospheric parameters. *(Tsang, et al., in prep)*



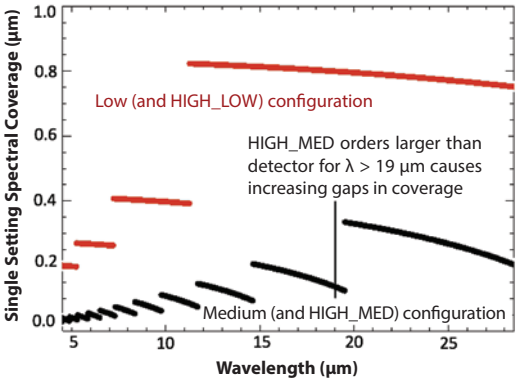
Specifications

EXES features an array dimension of 1024x1024 and a pixel size of 0.2 arcsec. High resolution is provided by an echelon (a coarse-ly-ruled, steeply-blazed, aluminum reflection grating) along with an echelle grating to cross-disperse the spectrum.

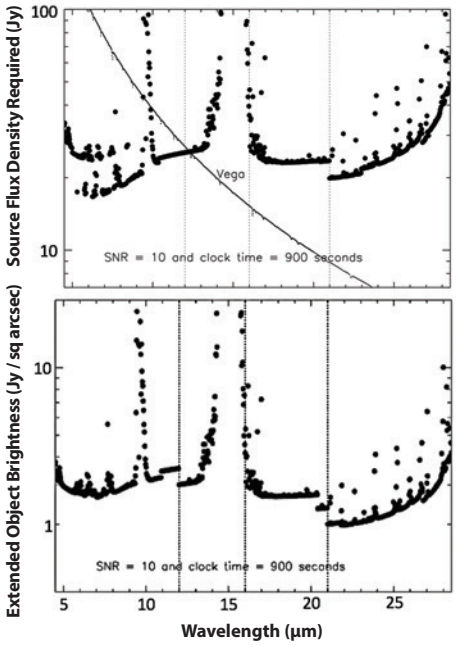
The echelon can be bypassed so that the echelle acts as the sole dispersive element, resulting in single order spectra at medium or low resolution depending on the incident angle.

The available configurations are Low (low resolution), Medium (medium resolution), HIGH_MED, and HIGH_LOW. Configurations are called HIGH_MED if the cross disperser echelle angle is 35-65° and HIGH_LOW for angles between 10-25°. The shorter slits in HIGH_LOW allow for more orders to be packed onto the array, thus increasing the instantaneous wavelength coverage while maintaining the same high spectral resolution as the HIGH_MED configuration.

Spectral Coverage



High Resolution



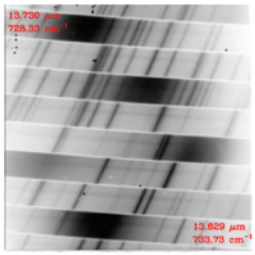
Above: Sensitivities for point *(top)* and extended *(bottom)* sources, assuming nominal conditions.

Spectral Parameters

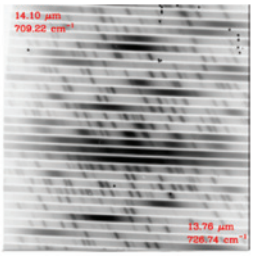
Configuration	Slit Length	Spectral Resolution
Low	25"–180"	1,000–3,000
Medium		5,000–20,000
HIGH_MED	1.5"–45"	50,000–100,000
HIGH_LOW	1"–12"	

In the Medium and Low configurations the slit lengths vary from 25" to 180" depending on the number of rows to be read.

HIGH_MED Configuration



HIGH_LOW Configuration



Left: Raw 2D spectra without nod-subtraction to highlight the sky emission lines *(dark)*. Possessing the same spectral resolution, HIGH_LOW has a larger spectral coverage at the expense of a shorter slit.