IGNIS for Keck: Next generation high resolution infrared spectroscopy

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Next generation high-resolution IR spectroscopy for Keck should improve upon the current capabilities offered with NIRSPEC by 1) providing larger wavelength grasp, 2) being more sensitive, and 3) having greater instrumental stability. IGNIS is a high-resolution (R~45,000) spectrograph that will obtain spectra across the full 1.07-5.4 μm bandpass, simultaneously, over 6 infrared detectors, with no moving parts in the spectrograph optics. The key technology that makes IGNIS possible is the use of silicon immersion gratings, which provide a 3.4x increase in dispersion while allowing for more compact instrument designs. The IGNIS optical design splits each wavelength channel allowing for better optimization of optics coatings. By combining broad spectral grasp with an efficient optical design, IGNIS will be highly sensitive and outperform upgraded NIRSPEC. Figure 1 shows sensitivity curves for IGNIS compared to other instruments. IGNIS is not only more sensitive than NIRSPEC by up to ~2 magnitudes per band, it will achieve the full 1.07-5.4 um grasp simultaneously, where upgraded NIRSPEC would require ~8 grating settings.

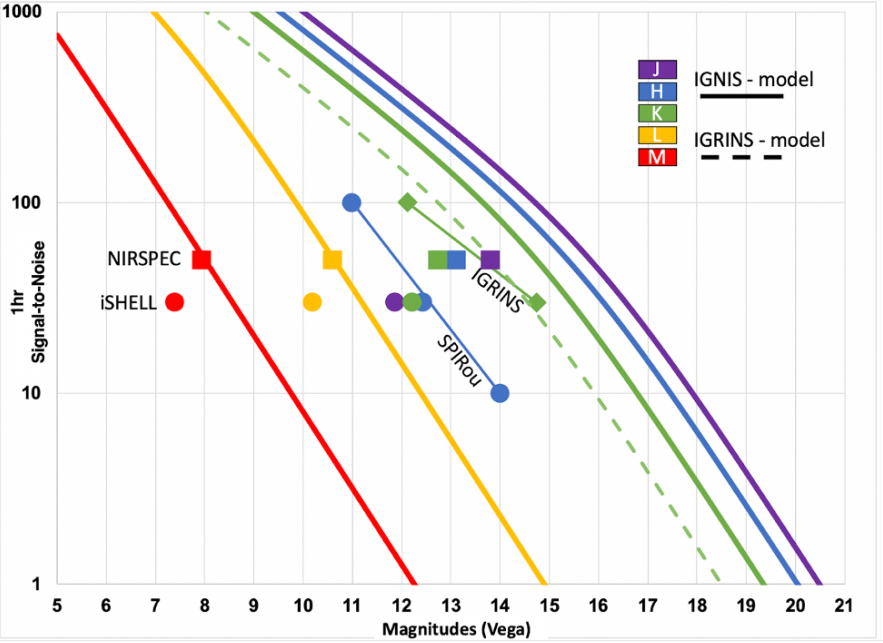

Figure 1. Modeled IGNIS sensitivity (1-hour SNR per resolution element at R~45,000) compared to other high-resolution IR spectrographs. Sensitivities for existing instruments are from actual observations, and an IGRINS model is compared here to actual IGRINS K-band performance.

Key IGNIS Science:

Planetary Science: IGNIS spectra across the ~2.8-5 um bandpass at high-spectral resolution will allow for easier study of cometary H2O, CO, H2CO, CH3OH, CH4, C2H2, C2H6, HCN, NH3, as well as product volatiles (NH2, OH, and CN) and isotopologues of hydrogen (D/H), nitrogen ($^{15}N/^{14}N$), and carbon ($^{13}C/^{12}C$). IGNIS covers key wavelength ranges to study trace species,

isotopologues, and organics in terrestrial planet atmospheres and enables the study of gas composition and cloud structure at deep levels in gas giant planets. These capabilities directly support NASA missions including: *Dragonfly to Titan, Europa Clipper, VERITAS and DAVINCI+ to Venus, and future comet and asteroid missions like DART*

Exoplanet Science: IGNIS' simultaneous wavelength coverage and high spectral resolution will enable exciting exoplanet science. IGNIS will characterize transiting exoplanet atmospheres, including their planetary temperatures, wind speeds, measure abundances of atomic and molecular species (including isotopes), and will do so 10 times more efficiently than any existing NIR high resolution spectrograph. IGNIS will be sensitive to a large sample of free-floating planetary mass objects to measure their rotational velocities, orbital inclinations, and planetary obliquities for studies of planetary system architectures and dynamics. These capabilities directly support NASA missions including: *TESS and JWST follow-up, Roman follow-up, Large O/UV/IR mission planning*

Stellar/Substellar Science:
IGNIS will be capable of obtaining spectra for any stellar source in the 2MASS catalogs, and permit the measurement of stellar parameters (temperature, log g, vsini, radial velocity, magnetic field) and detailed abundances. Additionally, IGNIS will map the surfaces of dozens of brown dwarfs using Doppler Imaging to measure their weather pattern evolution. Many brown dwarfs have never been observed at high spectral resolution, and IGNIS would be the first instrument sensitive enough to obtain spectra down to the planetary-mass boundary. These capabilities directly support NASA missions including: *Hubble, WISE, TESS and JWST follow-up, and will be Roman contemporaneous*

Galactic Science:
At the youngest ages, IGNIS will be capable of peering through the dense interstellar dust of star forming regions to probe the stellar photosphere and the inner disk where terrestrial planet formation occurs. Giant stars, at the end of their lives, will be observable across the Milky Way and within the dwarf galaxies and spiral galaxies in the Local Group. The sensitivity of IGNIS will be unmatched in the northern hemisphere, even with the initial suite of TMT instruments, and this will provide the best opportunity for transient and science at high resolution. These capabilities directly support NASA missions including: *Hubble, WISE, TESS and JWST follow-up, and will be Roman and SPHEREx contemporaneous*