The Cavity in the HD 100546 Disk: Spectral Imaging with TPF/Coronagraph and VLST

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In addition to high contrast imaging of mature planetary systems, spectral imaging has the potential to probe the chemistry, structure, and nature of circumstellar disks around stars making the transition from protoplanetary disk systems to young planetary systems. One such system is HD 100546. Spectral imaging with HST/STIS at Lyman alpha has revealed spatially extended reflection nebulosity, atomic gas, and molecular hydrogen. The STIS data also resolve a cavity in the inner 0.13" (13 AU), which is offset 0.05" to the SE of the star, consistent with dynamical clearing of the disk by a body on an eccentric orbit. The lack of chromospheric and transition region emission from a companion constrains it to be later in spectral type than M4-5V, which, at approximately 10 Myr, is consistent with either a brown dwarf or extra-solar giant planet. TPF-coronagraph will provide more complete imaging of the cavity, both in high contrast coronagraphic mode sampling $r > 0.08$", and via direct imaging with PSF subtraction. If equipped with an integral field spectrometer, TPF-C will be able to exploit its 0.4–1.7 μm wavelength coverage to map the disk albedo, and the location of water and methane ice in the disk at $R = 70$, providing a direct measure of the C/O ratio in the disk. At this resolution, H-α emission from a brown dwarf companion would be easily detectable. At $R = 3000$, TPF-C will be able to map the wind in this system, potentially accounting for the diffuse x-ray emission seen by Chandra, and will probe the disk photo-surface in [O I], [S II], [N II], and [Fe II]. At higher resolution ($R = 80,000$ to $100,000$) the disk dynamics can be mapped for the refractory and super-refractory grain populations. The principal limitation of TPF-C's wavelength coverage will be lack of access to some of the primary disk constituents, which can be addressed by VLST. With access to the vacuum UV, VLST will cover emission associated with OH, CO, and molecular hydrogen as well as providing access to a wealth of atomic gas transitions sampling volatiles, semi-refractories, lithophiles, siderophiles, and super-refractory elements.