Mark Marley, NASA Ames Research Center, mark.s.marley@nasa.gov

Characterizing Young Giant Planets with the Gemini Planet Imager: An Iterative Approach to Planet Characterization

After discovery, the first task of exoplanet science is characterization. However experience has shown that the limited spectral range and resolution of most directly imaged exoplanet data requires an iterative approach to spectral modeling. Simple, brown dwarf-like models, must first be tested to ascertain if they are both adequate to reproduce the available data and consistent with additional constraints, including the age of the system and available limits on the planet's mass and luminosity, if any. When agreement is lacking, progressively more complex solutions must be considered, including non-solar composition, partial cloudiness, and disequilibrium chemistry.

Such additional complexity must be balanced against an understanding of the limitations of the atmospheric models themselves. For example while great strides have been made in improving the opacities of important molecules, particularly NH_3 and CH_4, at high temperatures, much more work is needed to understand the opacity of atomic Na and K. The highly pressure broadened fundamental band of Na and K in the optical stretches into the near-infrared, strongly influencing the spectral shape of Y and J spectral bands. Discerning gravity and atmospheric composition is difficult, if not impossible, without both good atomic opacities as well as an excellent understanding of the relevant atmospheric chemistry.

I will present examples of the iterative process of directly imaged exoplanet characterization as applied to both known and potentially newly discovered exoplanets with a focus on constraints provided by GPI spectra. If a new GPI planet is lacking, as a case study I will discuss HR 8799 c and d will explain why some solutions, such as spatially inhomogeneous cloudiness, introduce their own additional layers of complexity. If spectra of new planets from GPI are available I will explain the modeling process in the context of understanding these new worlds.