Lyot Project and Gemini Planet Imager

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In this communication we briefly present some results obtained with the Lyot Project Coronagraph (Fig.1), and analyze the current performance of this instrument. We present the Gemini Planet Imager (GPI) project which will be on sky in 2010.

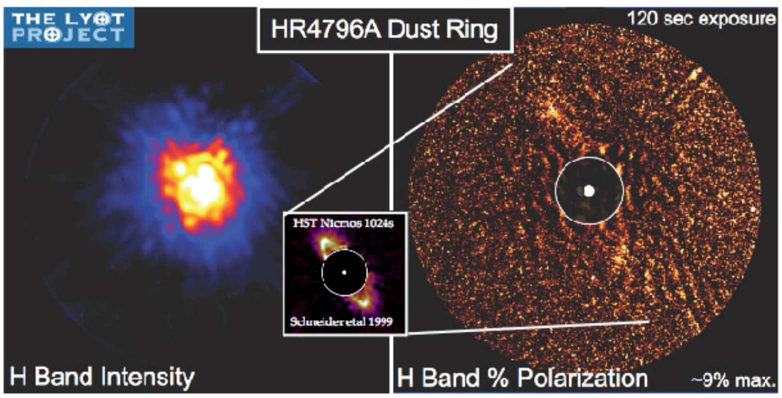

***Figure 1:** Preliminary detection of the dust ring around HR 4796A. The left image shows the H-band coronagraphic image, and the right image shows the polarimetric image. For compareson, the HST image (Schneider et al. 1999) is shown. This detection was obtained in only 120 s, to be compared to the 1024 s of the HST exposure. This image was obtained during the commissioning of the polarimetric mode, with only 3 out of 4 modes operating. New data are being analyzed that utilize the full polarimetric mode and deeper exposures.*

With Extreme Adaptive Optics and Coronagraphy, the current on-sky performance limitations are due to quasi-static speckles with lifetimes up to one hour, which are not easily calibrated and do not average over long exposures (Figs. 2 and 3). Next-generation ground-based instruments will have to overcome this limitation using speckle reduction techniques. The Gemini Planet Imager will include an active calibration system, and a spectrograph (Integral Field Unit) to help push the dynamic range further using speckle nulling and multi-wavelength calibration techniques (Fig. 4).

Ground-based projects like GPI and its European counterpart VLT-Sphere will be capable of observing a large target sample in young associations and the solar neighborhood. Detection rates based on Monte-Carlo simulations predict a detection of about 100 planets for a survey of about 500 stars (Fig. 5). Imaging and spectroscopy of giant planets, and polarimetric imaging of circumstellar dust disks, will help the understanding of planetary formation and evolution.

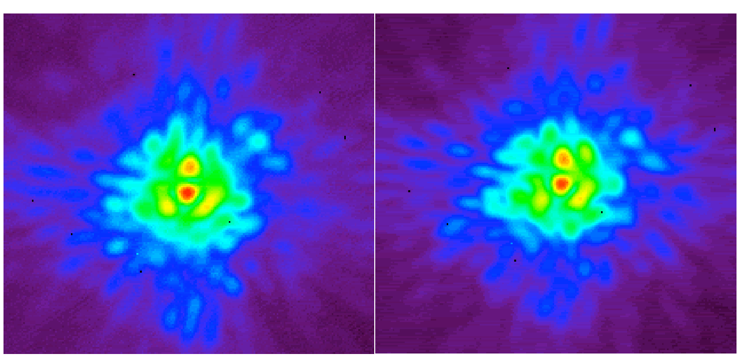

***Figure 2:** Illustration of quasi-static speckles on H-band coronagraphic short exposure images. The two images are separated by a few minutes. Several quasi-static structures can be identified on both images.*

On the instrumentation side, the presence of these slowly varying speckles in Extreme AO coronagraphic images makes the case of ground-based coronagraphy relevant for TPF. Although the speckle parameters vary by orders of magnitude between ground and space, ground-based instruments like GPI will implement speckle nulling and multi-wavelength calibration techniques. This will provide useful information and results for the preparation of TPF, in particular on the speckle reduction and calibration aspects for increasing the dynamic range

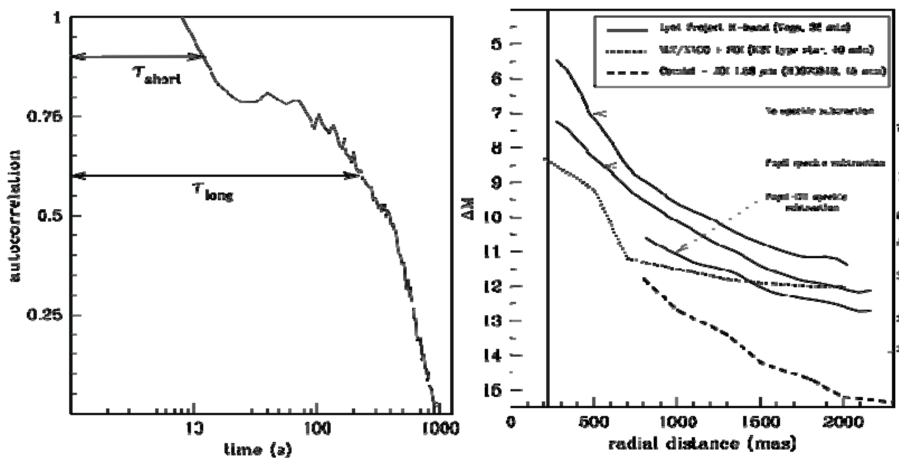

Figure 3: *Left: autocorrelation of the residual speckle in Lyot Project coronagraphic images, showing the short and long lifetimes. The long-lived speckles do not average over long integration times. Right: Lyot Project contrast performance obtained on Vega. Differential rotations at the Coudé focus have been used to remove some of the static speckles, resulting in an improvement of about 2 magnitudes in contrast.*

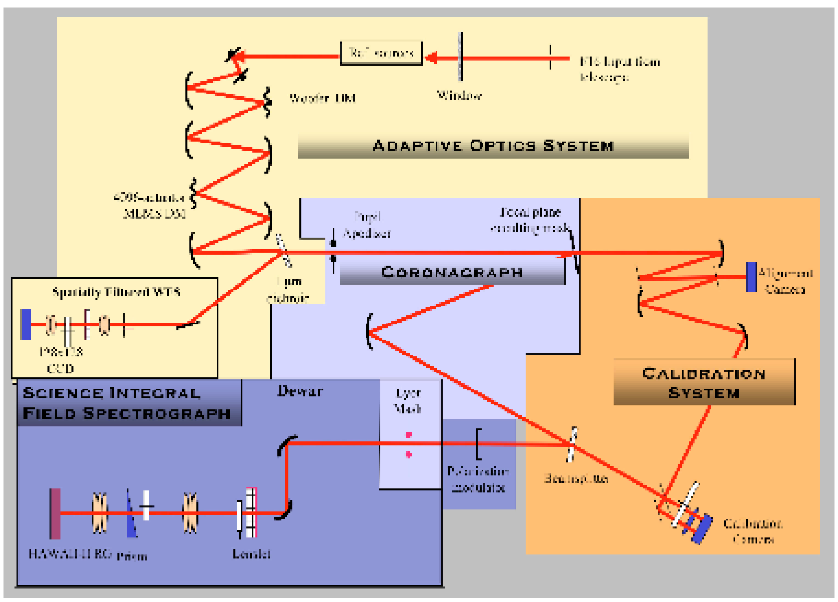

Figure 4: *Schematic layout of the Gemini Planet Imager. The system will include an Extreme Adaptive Optics system, an Apodized Pupil Lyot Coronagraph, a calibration system for quasi-static speckle reduction and an integral field spectrograph.*

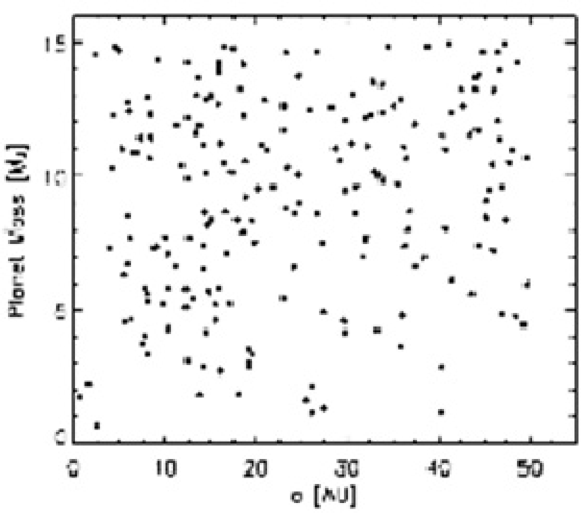

Figure 5: *The distribution of GPI-detected exoplanets in the semimajor axis/exoplanet mass plane. The detected planets are drawn from the field survey of nearby (<50 pc) stars (no age cut). This experiment samples semimajor axis and masses with uniformity*