GEMINI PLANET IMAGER EXOPLANET SURVEY (GPIES) OVERVIEW AND HIGHLIGHTS. J. Patience (ASU), Macintosh, B., Graham, J. R., Barman, T., De Rosa, R. J., Konopacky, Q., Marley, M. S., Marois, C., Nielsen, E. L., Pueyo, L., Rajan, A., Rameau, J., Wang, J. J. , Arriaga, P., Artigau, E., Brewster, J., Bruzzone, S., Bulger, J., Burningham, B, Burrows, A. S., Chen, C., Chiang, E., Chilcote, J. K., Dawson, R. I., Dong, R., Doyon, R., Draper, Z. H., Duchene, G., Esposito, T. M., Fabrycky, D., Fitzgerald, M. P., Follette, K. B., Fortney, J. J., Gerard, B., Goodsell, S., Greenbaum, A. Z., Hibon, P., Hinkley, S., Cotten, T. H., Hung, L.-W., Ingraham, P., Johnson-Groh, M., Kalas, P., Lafreniere, D., Larkin, J. E., Lee, J., Line, M., Long, D., Maire, J., Marchis, F., Matthews, B. C., Max, C. E., Metchev, S., Millar-Blanchaer, M. A., Mittal, T., Morley, C. V., Morzinski, K. M., Murray-Clay, R., Oppenheimer, R., Patel, R., Perrin, M. D., Rafikov, R. R., Rantakyro, F. T., Rice, E. L., Rojo, P., Rudy, A. R., Rufio, J.-B., Ruiz, M. T., Sadakuni, N., Saddlemyer, L., Salama, M., Savransky, D., Schneider, A. C., Sivaramakrishnan, A., Song, I., Soummer, R., Thomas, S., Vasisht, G., Wallace, J. K., Ward-Duong, K., Wiktorowicz, S. J., Wolf, S. G., Zuckerman, B., Blunt, S., Vega, D.

Scientific Context: Over 2500 exoplanet systems have been discovered to date [1], and their study has prompted enormous progress in our understanding of the formation and migration of giant planets, and of the importance of factors such as stellar mass [2,3], metallicity [4], and binarity [5,6]. Despite the thousands of exoplanets known, only a limited number are amenable to characterization of their atmospheres, one of the forefront areas of research in the field. Direct images of exoplanets offer unique information about the presence and properties of exoplanets in wide orbits, and provide a key spectroscopic comparison [7, 8, 9] to the atmospheres of transiting exoplanets that are heavily influenced by irradiation and tides from the host star [10, 11]. Systems with giant planets in wide orbits will be very attractive targets for future observations and terrestrial planet searches, given the scattering and capture planetesimals by giant planets that may be crucial to shielding the terrestrial planet zone and to the development of life [12]. By contrast, the process by which a Hot Jupiter reaches its short period orbit may disrupt inner disk material [13], and Hot Jupiters are typically not members of multiple planet systems [14].

The Gemini Planet Imager Exoplanet Survey (GPIES) Scope: The Gemini Planet Imager (GPI) is a next-generation coronagraphic integral field unit [15] with the sensitivity and resolution to detect planetary companions with separations of 0.2-1.0 arcseconds around a large set of stars. An 890-hour GPI survey of 600 young (~5-300 Myr), nearby (<~100pc) stars commenced in late-2014, and approximately half of the survey stars have been observed thus far. Survey observations are conducted in H-band, with follow-up possible over the Y-K bands. The sensitivity reaches Jupiter to few-Jupiter masses depending on the target age, spectral type, and distance.For a subset of targets with excess emission above the level of the stellar photosphere indicative of debris disks, polarimetry observations are also obtained. The central survey aims are: (1) the discovery of a population of giant planets with orbital radii of 5-50 AU comparable to Solar System gas giant orbits, (2) the characterization of the atmospheric properties of young planetary companions, and (3) spatially resolved imaging of debris disks.

Initial Results from the GPIES Program: From the companion search component of the survey, a planetary companion to the young star 51 Eri was discovered [16] and astrometrically comfirmed [17] with GPI, and more comprehensive characterization of the exceptionally cool atmosphere among known imaged exoplanets is ongoing [18]. A brown dwarf companion to the debris disk star HR 2562 was also discovered, with the location of the brown dwarf likely within the debris disk [19]. Among the imaged exoplanets known prior to the start of the GPI survey, the atmospheres and orbits have been characterized for the planets orbiting HR 8799 [20], Beta Pic [21, 22], and HD 95086 [23, 24]. From the debris disk component of the survey, a newly resolved disk has been mapped around the planet-host star HD 106906 [25], and the structure is remarkably asymmetric. Spatially resolved polarization maps have also been obtained for the known debris disk systems HR 4796 [26], HD 131835 [27], and HD 15787 [28]. The spectroscopic and astrometric measurements provide empirical constraints on atmosphere and evolutionary models, while the disks reveal a diversity of structures, potentially induced by interactions with planets.

References: [1] www.exoplanets.eu. [2] Laughlin et al. 2004. [3] Johnson et al. 2010. [4] Fischer & Valenti 2005. [5] Patience et al. 2002. [6] Ngo et al. 2015. [7] Barman et al. 2011. [8] Skemer et al. 2012. [9] Patience et al. 2010. [10] Deming et al. 2005. [11] Sing et al. 2008. [12] Horner & Jones, Wetherill 1994. [13] Ida & Lin, 2008. [14] Wright et al. 2009. [15] Macintosh et al. 2014. [16] Macintosh et al. 2016. [17] De Rosa et al. 2016. [18] Rajan et al. 2017. [19] Konopacky et al. 2016. [20] Ingraham et al. 2015. [21] Chilcote et al. 2016. [22] Wang et al. 2016. [23] De Rosa et al. 2015, [24] Rameau et al. [25] Kalas et al. 2016. [26] Perrin et al. 2015. [27] Hung et al. 2015. [28] Millar-Blanchaer et al. 2016.