

ExoPAG meeting summary

June 24-25, 2010, Pasadena

The 2nd meeting of NASA's ExoPAG was held in late June, 2010, in Pasadena. Topics of discussion included reports from our five Science Analysis Groups, or SAGs, along with a discussion of the utility of astrometry as a precursor to a direct imaging mission, and a proposal by Wes Traub, Exoplanet Chief Scientist, for a double-blind study of direct imaging missions. The results of these discussions are briefly summarized below. A presentation on these results was given at the July 7-8 Astrophysics Subcommittee (APS) meeting by Jim Kasting, ExoPAG Chair (see related PowerPoint presentation). The talks themselves are posted on the ExoPAG website at:

<http://exep.jpl.nasa.gov/ExoPAG/exopag2/agenda/>

SAG 1--Debris Disks and Exozodiacal Dust

Aki Roberge, Chair of this SAG, gave a presentation on what is known about the brightness and other characteristics of debris disks around other stars, referred to as the *exozodiacal light*, or *exozodi*. Disk brightness is measured in units of *zodis*. 1 zodi is the estimated brightness of our own local zodiacal dust cloud, thought to be about 10^{-7} that of the Sun. It is difficult to measure the brightness of the exozodi signal around other stars, and this could pose significant problems for future direct imaging missions. Aki also pointed out that zodiacal dust clouds are expected to be asymmetric as a result of planetary perturbations, and this further complicates the future detection of planets around other stars.

Aki's talk was followed by related presentations by Tom Greene, Phil Hinz, Charley Noecker, Christine Chen, and Gene Serabyn. See their PowerPoint talks for details. Phil gave an update on the status of the Large Binary Telescope Interferometer (LBTI) being built at the University of Arizona. The equipment is scheduled for installation on LBT in September, 2010, and high precision nulling observations are scheduled to begin in 2012. Christine pointed out that LBTI should be capable of observing warm (inner planetary system) disks down to 10 zodis, as compared to the current limit of ~200 zodis from the Keck Interferometer. As such, LBTI is considered to be a critical development in this area. This group hopes to issue a report later this year.

SAG 2-- Potential for Exoplanet Science Measurements from Solar System Probes

Dave Bennett (co-Chair of this group, along with Dan Coulter) gave a presentation on the capabilities of Solar System probes in performing exoplanet observations. Three different types of observations were mentioned: zodiacal light studies, exoplanet transits, and microlensing observations. A spacecraft looking back from the outer Solar System might be able to measure the brightness of our own local zodi better than it is currently known. Exoplanet transits could be observed from existing spacecraft, particularly Cassini, which is currently in orbit around Saturn. Observations of

microlensing events from Cassini could, through parallax effects, provide information about planets that is not obtainable from the ground-based observations.

A workshop studying the possible synergies between exoplanet exploration and Solar System missions was held at the Kavli Institute for Theoretical Physics at U.C. Santa Barbara in May, 2010. One thing that came out of this workshop was a better understanding of some of the difficulties in establishing such collaborations. PIs of planetary missions are generally reluctant to turn on their instruments prior to the main data-collecting phase of their missions. Hence, unless exoplanet observations are included as part of the original plans for such a mission, it is wisest to consider such observations as part of the extended mission phase for such probes. This group also hopes to write a report by the end of this year.

SAG 3--Planetary Architecture and Dynamical Stability

SAG 3 Chair Brad Hansen was absent from this meeting, so the discussion was led by Rory Barnes from the University of Washington. Rory talked about what must be known about planetary systems in order to determine the stability of planetary orbits within the habitable zone. Also, what constraints can be placed on habitable zone stability for known exoplanet systems? Everyone agreed that this is a fruitful area for research. There was less agreement on whether to attempt a report within the next few months.

SAG 4--Planetary Measurements Needed for Exoplanet Characterization

Lisa Kaltenegger, SAG Chair, gave a talk about what do we need to know to characterize an exoplanet. Perhaps more importantly, how well do we need to measure things in order to make that characterization? This is not a solved problem. It was generally agreed that this is a long-term effort. Several previous studies of this topic have been published over the last decade, e.g., D. DesMarais et al., *Astrobiology* (2002) and the TPF-STDT report published in 2006. It will make more sense to revisit this topic after the results of the Astro 2010 Decadal Survey report have been published, so that we have a better idea of what missions may fly over the next 10 years. So, stay tuned..

SAG 5--State of External Occulter Concepts and Technology

Charley Noecker, Chair of SAG 5, gave a talk in which he reviewed the technical basics for occulter and began to synthesize studies from various groups who have studied them. Charley's team includes members from several previous occulter mission studies. Both flagship missions like New Worlds Observer and smaller missions like the New Worlds Probe (flying an occulter with JWST) and the Orbiting Ozone Occulter (O3) were discussed. A flagship mission would have the advantage that the telescope spacecraft itself could be instrumented with alignment guidance sensors. For the JWST occulter, all alignment capability must be built into the occulter, making this technically more challenging.

Other members of the occulter group also gave informative presentations. Remi Soummer described a detailed study of the use of JWST with an occulter. Stuart Shaklan from JPL led a team that has performed detailed analyses of technical specifications for

various occulter missions, and they appear to be converging on their technical specifications. In doing so, Stuart has engaged most of the existing occulter mission teams and has achieved consensus on the results of the work—something that was lacking as recently as a year ago. This puts the exoplanet program in a position of being able to pursue candidate occulter missions with a sense of confidence in the mission and payload definition and performance estimates. We thank Stuart for performing this task.

This group hopes to issue a report by September of this year, timed to coincide with the release of the Decadal Survey.

Non-SAG business:

- i) Panel discussion on the utility of astrometry as a precursor for direct imaging missions

Jeremy Kasdin and his student Dmitry Savransky from Princeton, Mike Shao from JPL, and Remi Soummer from STScI gave a series of short presentations on whether a future direct imaging mission could benefit from a prior astrometric mission. The answer to this question turns out to depend critically on how exactly the question is asked. In general, prior information is more useful in cases where the frequency of Earth-like planets (η_{Earth}) is low or where the telescope is large, so that many potential targets can be observed. It also depends on whether the direct imaging mission is an internal coronagraph (which can slew from target to target relatively easily) or an occulter (which cannot). Information about the existence of Earth-like planets can in some cases be useful even if the detailed phase of the planet's orbit is lost in between the astrometric observations and the direct imaging mission. Whether or not this is a critical issue will depend in part on the results of the Decadal Survey, which will likely determine whether an astrometric or direct imaging mission will be flown within the next 10 years.

- ii) Proposed double-blind study of direct imaging missions

Wes Traub, Exoplanet Chief Program Scientist at JPL, discussed a proposed “double-blind” study of imaging missions. This study is designed as a followup to the double-blind study of RV/astrometric measurements, which had as its goal to determine whether such measurements could pick out hypothetical planetary systems from signals involving multiple planets and realistic noise sources. Wes's talk was followed by a vigorous discussion, in which some members of the audience questioned whether it was possible to perform such a study reliably, given the variety of different direct imaging missions that have been studied (including, for example, both probe-class and flagship missions) and the poorly defined system architecture for some of these. No consensus was reached on this topic, nor was one sought. This study will also be perceived as more or less urgent, depending on the forthcoming results from the Decadal Survey.

Next meeting

The next ExoPAG meeting will be held following the AAS meeting in January, 2011, in Seattle. An agenda for this meeting will be developed during the Fall. Please send suggestions for topics to Jim Kasting, ExoPAG Chair, or to anyone on the Steering Committee.