ExoPAG Report

APS Meeting, Washington DC
February 17, 2011

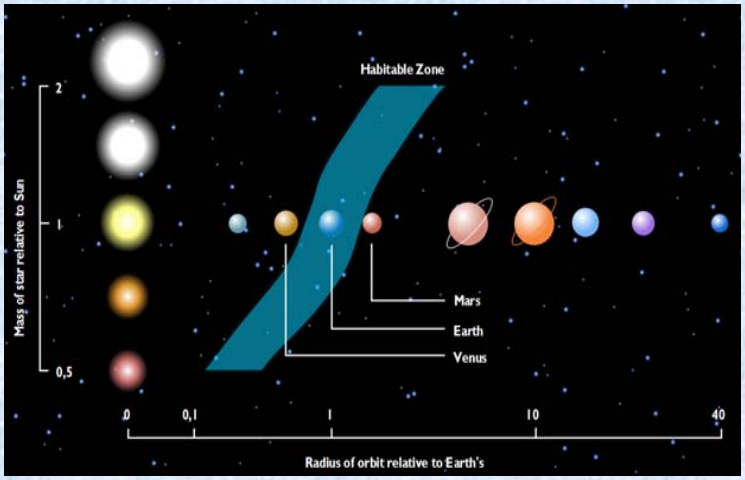
James Kasting, ExoPAG Chair

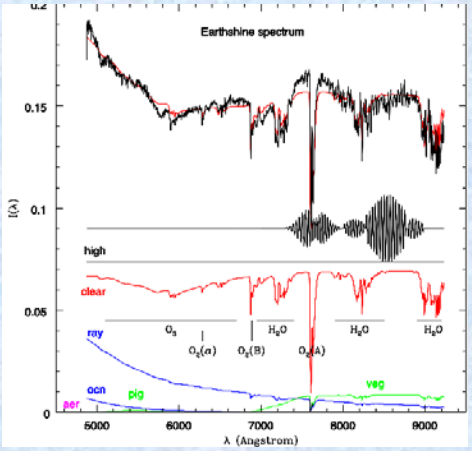
ExoPAG 3 Meeting

- ExoPAG 3 was held Jan. 8-9, 2011, in Seattle, just prior to the Winter AAS meeting
- Approximately 60-70 researchers attended
- Topics of discussion
  - Astro2010 overview and NASA's response (Alan Dressler/Doug Hudgins)
  - ESA Exoplanet Program briefing (Malcolm Fridlund)
  - Discussion of NASA Exoplanet Technology Program (Peter Lawson/Michael Moore/others)
  - Planning for a flagship mission for the next decade (All)
  - Ground-based RV surveys
    - i) Can they find Earth-mass planets? (Andrew Howard)
    - ii) Status of Kepler followup (Nick Gautier)

ExoPAG3: Points of scientific agreement

1. **The exoplanet science community's goal for a flagship space mission should be to find and characterize Earth-sized planets in the habitable zones of nearby F-G-K-M stars**
   - If we don't shoot for this goal, we won't be competitive with large ground-based telescopes in 10-20 years, and we won't satisfy the curiosity of the general public

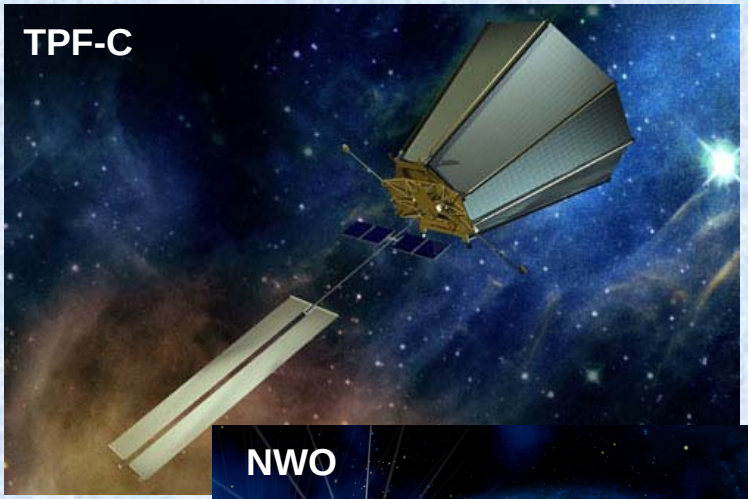


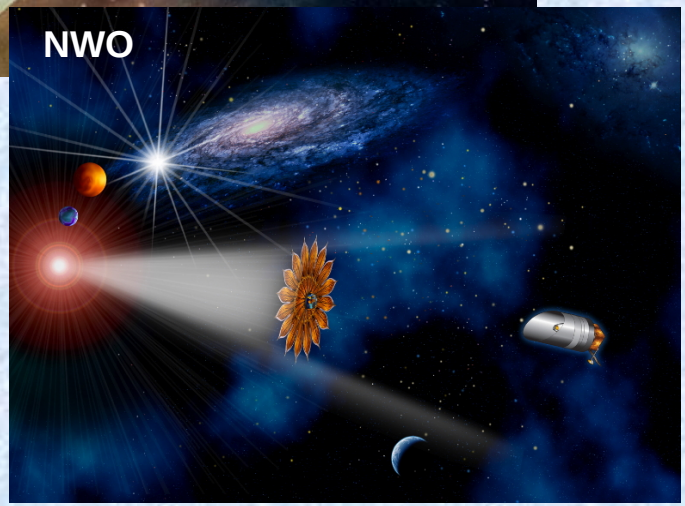


Woolf et al., ApJ 2002

Points of scientific agreement (cont.)

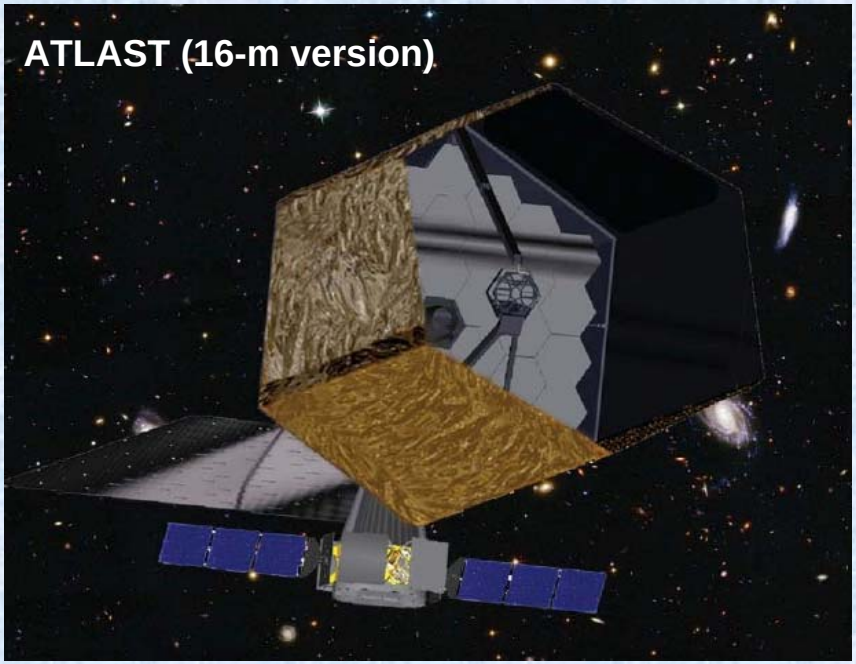
2. **The next flagship mission should be a large optical telescope, perhaps with UV and near-IR capability as well**
   - **The UV capability is not strictly required from the standpoint of exoplanet science but is considered important in gaining broad community support**
   - Because this mission would have broad support from the astronomical community, it should not be viewed as a dedicated exoplanet mission
   - Such a mission could satisfy Point 1 if equipped with a capable internal coronagraph, external occulter, or both
   - Interesting atmospheric spectral features are available within this wavelength range, including the O_2 A-band at 760 nm, O_3 bands in both the visible (520-680 nm) and UV (200-300 nm), and several bands of H_2O longward of 700 nm. Additional useful spectral features of CO_2 and CH_4 are available in the near-IR beyond 1000 nm
   - Gaining support for such a mission, including commitments for contributed components, from the international community should be actively pursued





Points of scientific agreement (cont.)

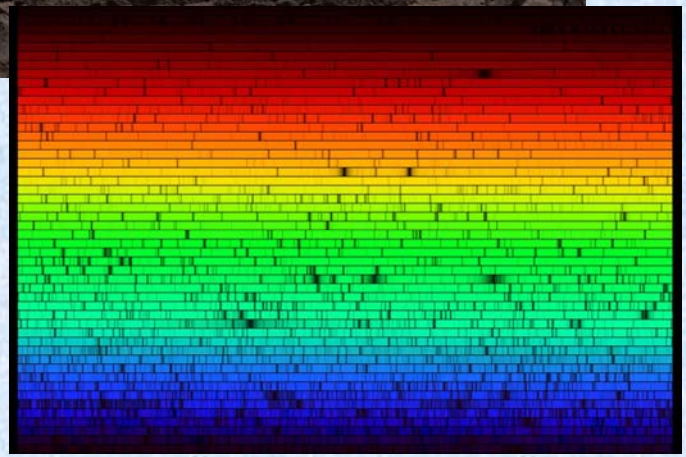
3. **The size of the aperture needed to satisfy Point 1 above as well as general astrophysics goals remains to be determined, but is likely to be ≥ 4 meters**
   - **Some astronomers argue that a larger (8-16 m) telescope will be needed in order to excite the interest of the general astronomical community and to compete with 30 m-class ground-based telescopes**
   - From the standpoint of exoplanet science, making this decision intelligently requires better information about η_{Earth} (which we should get from Kepler) and about typical exozodi levels (for which we will get some, possibly enough, information from LBTI)



http://www.stsci.edu/institute/atlast

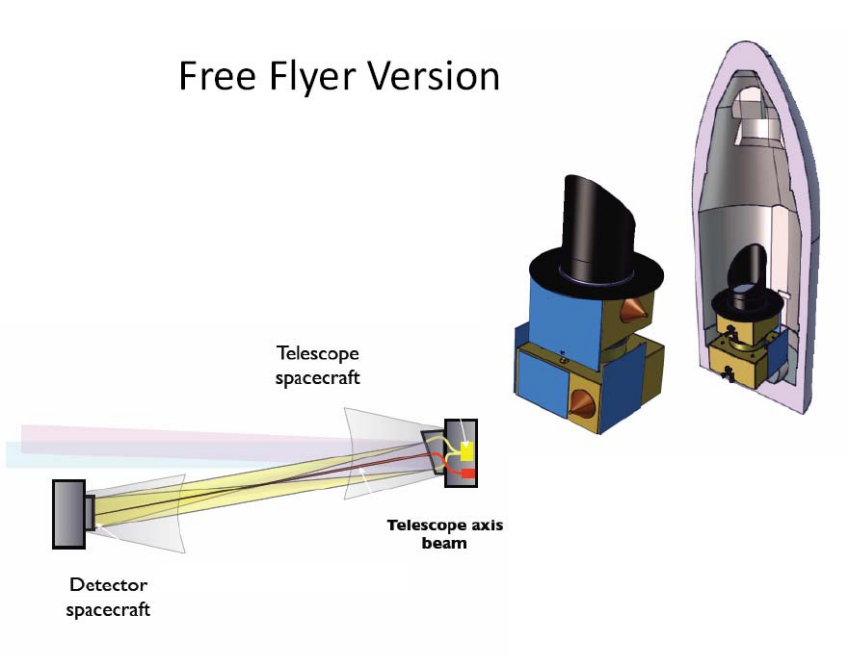
Points of scientific agreement (cont.)

4. **A significant increase in available time for precision radial velocity work, coupled with a new generation spectrograph(s), could contribute enormously to our general knowledge of exoplanets**
   - Whether this increased capability should be funded by NASA or by NSF is not our decision to make, but it would be an invaluable scientific facility in either case
   - **However, it appears unlikely that a target list of potentially habitable, Earth-mass planets around nearby solar-type stars can be derived from ground-based radial velocity measurements, despite anticipated improvements in precision.** The limiting factor is the noisiness of the host stars themselves



Points of scientific agreement (cont.)

5. **In order to fully characterize an exoplanet, we need to know its spectrum, its actual mass, its orbit (semi-major axis and eccentricity), and perhaps other information, as well**
   - These parameters do *not* all have to be determined simultaneously or in a particular order. Specifically, this means that an astrometry mission need not precede the direct imaging mission. **But, a space-based astrometry mission will likely be needed at some point to determine the true mass of any Earth-sized planets that are found**
   - Determining an exoplanet's orbit requires multiple revisits (at least 5 or 6, according to the 2006 TPF-C report). Knowing a planet's semi-major axis is critical for estimating its surface temperature, which is difficult or impossible to determine spectroscopically, and hence for determining whether a planet might be habitable



NEAT: Nearby Exo-Earth Astrometric Telescope (proposed to ESA)

ExoPAG-3 Proposed Resolutions

- NASA should not continue to invest in infrared interferometry as the basis for a future New Worlds Flagship Mission; coronagraphs (including VNC) and external occulters represent the most viable mission architectures.
- The ExoPAG recognizes the need to get to a mid-decade technology downselect as described in Astro2010. Further, it is crucial that the community buy into the process and will accept and support the outcome, whatever that outcome might be.
- That process will include both continued support for technology development related to coronagraphs and external occulters (e.g. SAT/TDEM) and concept studies of a set of missions in these two categories.
- Next-gen UVOIR telescope community must be engaged with the process from the very beginning (including participation in SAGs).

ExoPAG-3 Proposed Resolutions

Concept studies: (Timeline is negotiable—could be speeded up)

Present – Spring 2012

- SAGs will define the minimum science requirements for the mission to achieve a top rating in the 2020 decadal survey
- SAGs will coordinate to define bounds for the scope and content of the studies and a set of "ground rules" to be followed so that the results of the two studies are as directly comparable as possible.
- SAG output presented and discussed at ExoPAG-5 in Jan. 2012, finalized by Spring 2012.

Summer 2012

- NASA Headquarters issues solicitation for participation in Interim Science Working Groups (ISWG) to conduct (funded) concept studies; membership of working groups selected by end of 2012.

ExoPAG-3 Proposed Resolutions

Concept studies (continued):

Jan. 2013

- Concept studies begin.

Jan. 2014

- Concept study reports completed and submitted to NASA

Summer 2014

- Senior Review-style evaluation of the concept study reports conducted.
  - Organized by NASA HQ
  - ISWGs present the results of their study in a face-to-face meeting with review panel, discuss any issues/questions with the panel.

December 2014

- Review panel submits report to NASA summarizing their findings and recommendations for the architecture downselect.

2015

- Report and resultant NASA decisions fed into DSIAC.

- Key concern: Will TPF technology be sufficiently far enough along by 2015 to allow the mission architecture downselect to be performed intelligently?
  - Additional funding would, of course, be welcomed