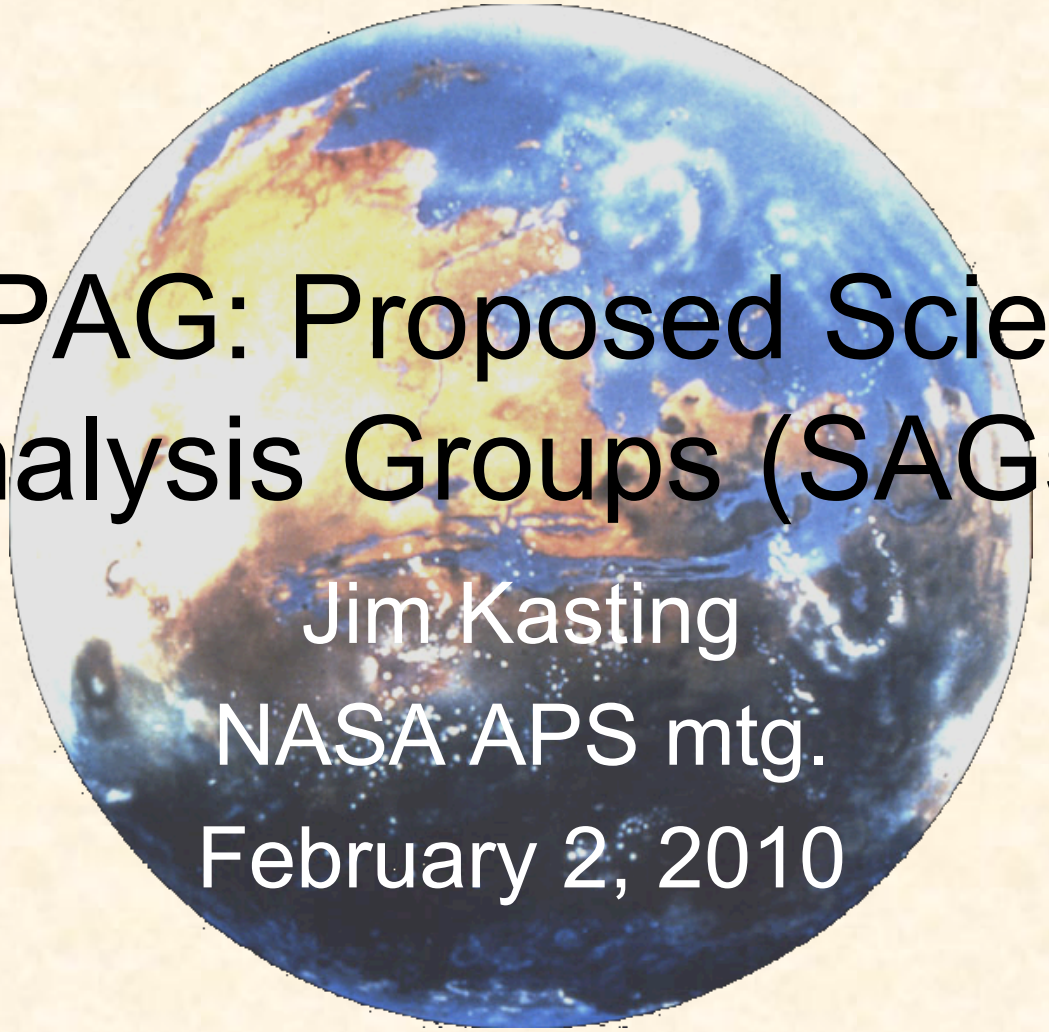


ExoPAG: Proposed Science Analysis Groups (SAGs)

Jim Kasting

NASA APS mtg.

February 2, 2010

ExoPAG Steering Group

Steering committee:

Jim Kasting (Penn State)--Chair

Aki Roberge (NASA Goddard)
Dan Coulter (JPL)
Tom Greene (NASA Ames)
Bruce Macintosh (Lawrence Livermore)
Dave Bennett (Notre Dame)
Charley Noecker (Ball Aerospace)
Brad Hansen (UCLA)
Lisa Kaltenegger (Harvard Smithsonian)
Alycia Weinberger (Carnegie Institute)

Ex-officio:

Wes Traub (JPL)

Doug Hudgins, Lia LaPiana (NASA Headquarters)

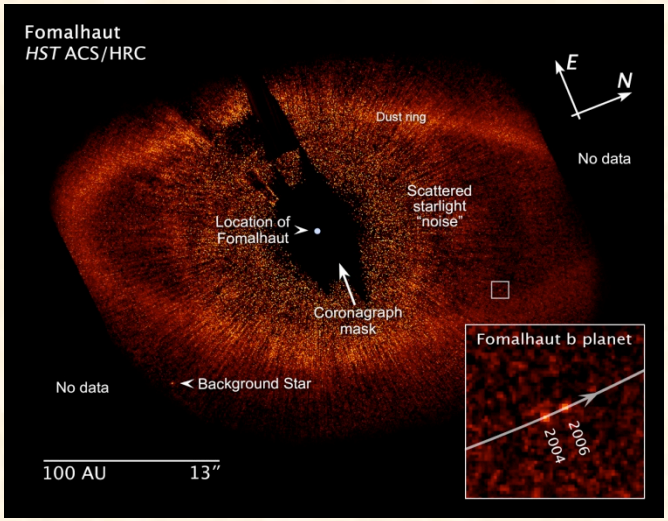
Initial ExoPAG meeting

- Jan. 7-8, Washington DC
- Held in conjunction with the American Astronomical Society meeting
- Over 100 attendees
- Two half-days of discussion
  - Defining the purpose and scope of the ExoPAG
    - Mike Meyer from NASA Headquarters discussed the role of MEPAG in the Mars Exploration Program
  - Identifying potential topics on which to establish specific Science Analysis Groups (SAGs)

List of potential SAGs

1. Debris disks and exozodiacal dust
2. Potential for exoplanet science measurements from Solar System probes
3. Planetary architecture and dynamical stability
4. Planetary measurements needed for exoplanet characterization
5. State of external occulter concepts and technology

1. Debris Disks & Exozodiacal Dust



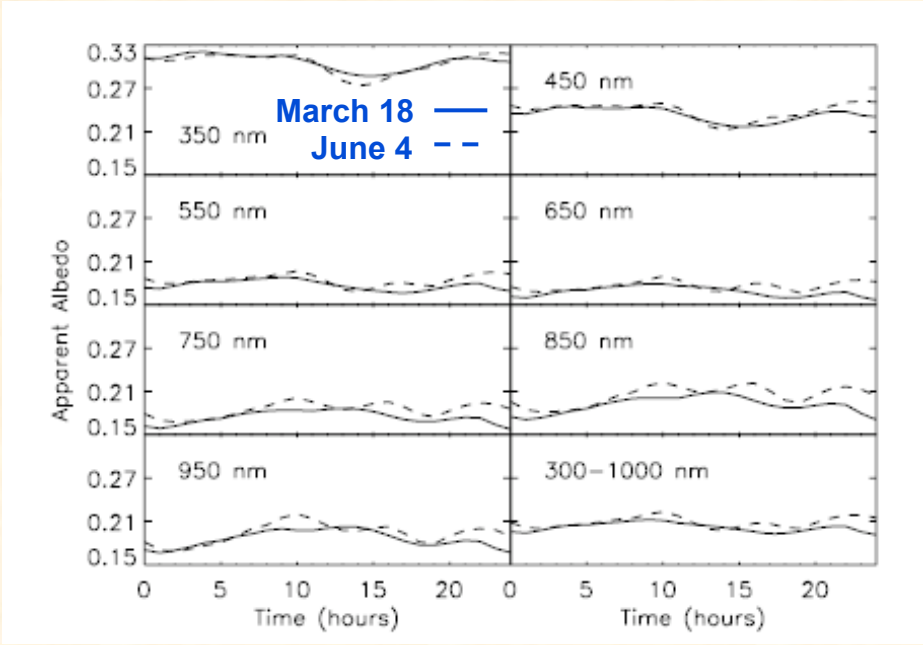
Kalas et al. (2008)

- **Objective:** Determine full impact of exozodiacal dust on future direct imaging and spectroscopy of exoplanets
  - Overall community goal; beyond scope of single SAG
- **Participants:** Debris disk observers & theorists, members of past and present exoplanet mission teams
- **Products:**
  1. Report existing information about impact of exozodiacal background on various exoplanet mission concepts
     - Describe what additional analyses should be done by mission concept teams; request they perform them in a uniform fashion
  2. Report reliable information on expected sensitivity of all upcoming facilities for measurements of debris dust
  3. Organize theoretical study to produce expected distribution of exozodi levels

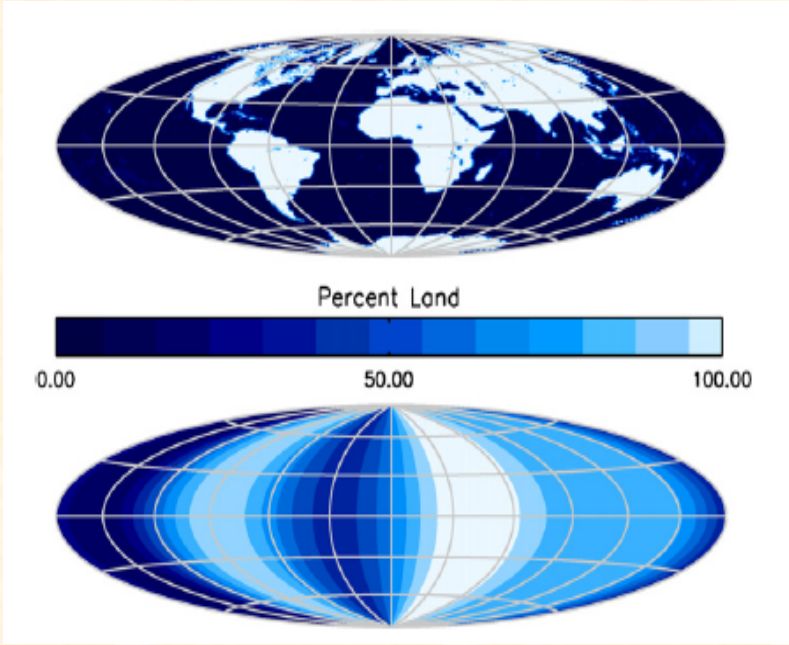
2. The Potential for Exoplanet Science Measurements From Solar System Probes

- **Objective:** investigate the scientific potential and practicality of doing exoplanet science with small, low impact instruments from the platform of a solar system probe during the cruise phase of the mission
  - Zodiacal light studies
  - Transits
  - Microlensing observations
- **Participants:** scientists, engineers, theorists and NASA leadership from the exoplanetary and planetary science communities
- **Product:** report on potential exoplanet science that could be performed from the platform of a solar system mission including
  - Top level exoplanet science goals
  - Top-level instrument concepts (including ROMS for cost, mass, volume, power…)
  - Potential solar system missions which could accommodate exoplanet science instruments
  - Preliminary assessment of impacts of exoplanet science instruments on solar system mission.

SAG 2 example: EPOXI results



EPOXI light curves for Earth



Inferred land/ocean distribution

- Time-resolved light curves can be used to infer land/ocean distribution, presence of clouds, and planetary rotation rate

N.B. Cowan et al., Ap.J. (2009)

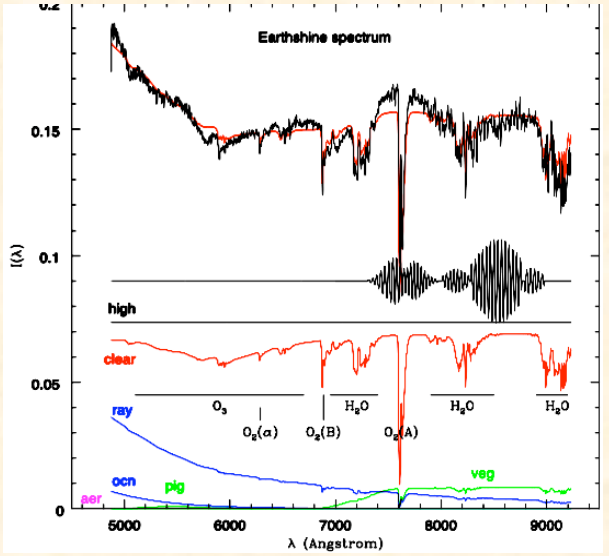
3. Planetary Architecture and Dynamical Stability

- **Objective:** Study the effects of planetary systems on planets within the habitable zones of nearby (and distant) stars
  - How well do we need to know the masses and orbits of other planets in a system to characterize a planet's orbital and climate stability?
  - How can we best obtain this information a) for nearby stars? b) in a statistical sense?
- **Participants:** Theorists and observers interested in different techniques (ground-based direct imaging, astrometry, microlensing)
- **Products:**
  - A list of nearby systems that either might or might not harbor habitable planets
  - An analysis of how statistical information about planetary system architecture might guide our search for habitable planets

http://www.idis-dyn.europlanet-ri.eu/

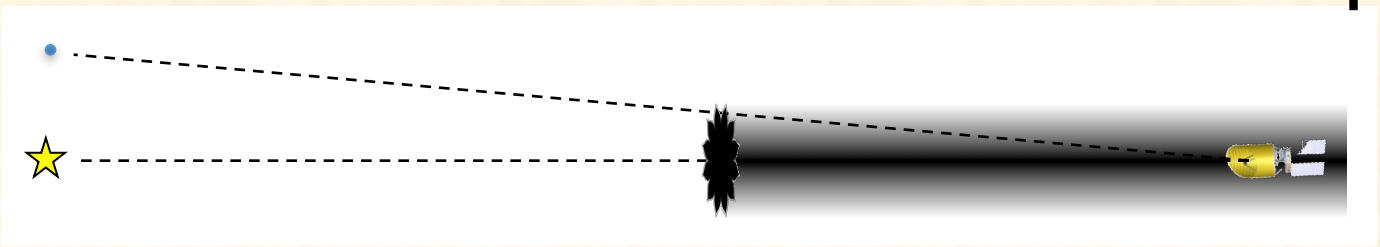
4. Planetary Measurements Needed for Exoplanet Characterization

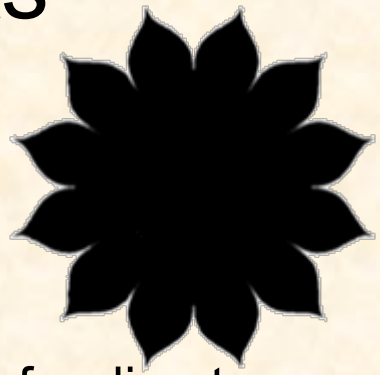
- **Objective:** Determine
  - which measurements are needed to characterize large and small exoplanets,
  - how accurate they must be,
  - how difficult they are to obtain, and
  - which might be done from the ground
- **Participants:** Atmospheric and surface modelers, ground and space observers, and exoplanet mission teams
- **Products:**
  - List of measurements and required precisions needed to understand a planet's state to different levels of completeness
  - List of measurement techniques that look over different time frames, and which of these can only be done from space



Woolf et al., Ap.J. 2002

5. Description and technology status for external occulter concepts





- **Objectives:**
  - Describe the features of external occulter concepts for direct detection imaging of exoplanets
  - Summarize the various estimates of potential scientific harvest
  - List the technology tall poles and assess the prospects
  - Provide information to JWST on the state of occulter technology
- **Participants:** members of the principal advocacy teams for external occulters
- **Product:** report on challenges and potential benefits of external occulter missions
  - Top-level instrument concepts (summarizing ASMCS studies and other sources)
  - Published estimates of exoplanet science harvest
  - Known technology challenges and plans for addressing them

Action item for APS

- Determine which, if any, of these tasks to charge us with and when you would like to see the reports