Understanding Other Worlds: NASA's Missions to Find and Characterize Extrasolar Planetary Systems

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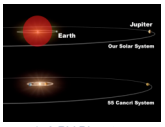
Introduction

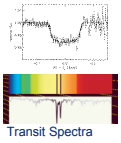
About 150 extrasolar planets, mostly much more massive than the Earth, are now known from ground-based observations. Earth-mass planets are very hard, if not impossible, to detect from the ground. The study of planets like our own Earth, orbiting in a 'habitable zone' around their parent stars, will require a new generation of space-based instruments.

What we Know Today:

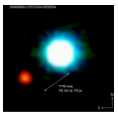


150 RV Planets

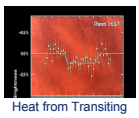
5 Transit Planets



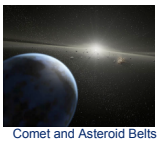
Transit Spectra



Hot Young Jupiters



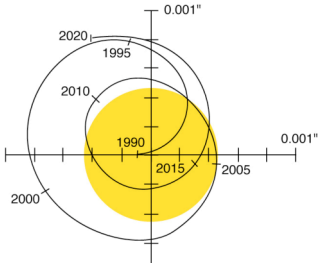
Heat from Transiting Jupiters



Comet and Asteroid Belts

Planet Detection with SIM PlanetQuest

SIM Planetquest detects the 'wobble' of the planet's pull on the star. It will devote up to half of the available observing time to planet detection. SIM is a versatile pointed instrument that will also do many other scientific studies in stellar, galactic, and extragalactic astrophysics. Due for launch in 2011.



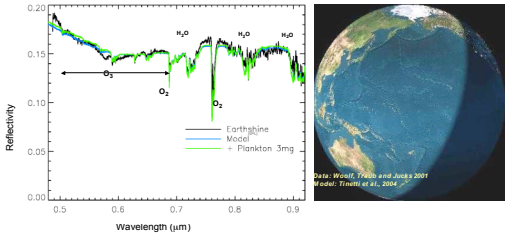
The 'wobble' of our Sun, as seen from 30 light years (Jupiter's tug = 0.5 milliarcsec, Earth's = 0.3 microarcsec)

SIM will conduct three distinct planet searches:

• **A Deep Search** for terrestrial planets around the nearest ~250 stars, using the full capability of the spacecraft to perform differential astrometry at 1 μas precision.

• **A Broad Survey** of a much larger (~2000 star) sample (at ~4 μas accuracy), including early and late-type stars, to set in context the great diversity of extrasolar planets.

• **A Search for Planets around young stars**, since virtually all of our current knowledge of planetary systems is based on mature systems which may have ceased any significant evolution.

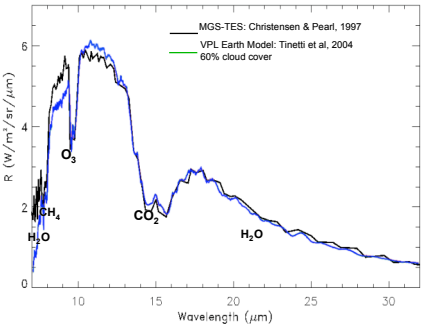


Optical Detection and Spectroscopy with TPF-C

• **Search** for terrestrial planets in the habitable zones around the nearest ~120 stars

• **Spectroscopy** (R ~ 70) of detected planets for indicators of habitability:

- O_2 (life) & water (habitability) are relatively easy to detect
- Surface biosignatures such as chlorophyll may also be detectable
- Drivers for instrument wavelength range:
  - CO_2 bands at 1.06 and 1.2 μm

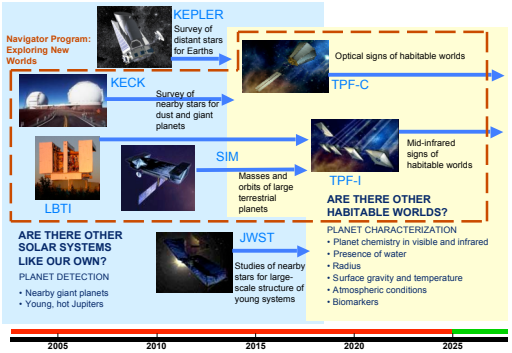


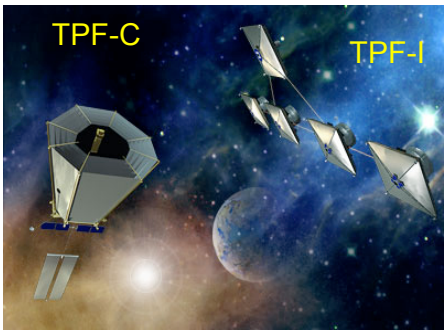
Mid-IR Detection and Spectroscopy with TPF-I

• **Search** for terrestrial planets in the habitable zones around the nearest ~120 stars

• **Spectroscopy** (R ~20) of atmospheres of detected planets for indicators of habitability:

- Atmospheric temperature
- CO_2 feature at 15 μm is very strong
- O_3 feature at 9 μm is very strong
- Drivers for instrument wavelength range:
  - Water bands at > 17 μm
  - Methane and water at < 8 μm





Artist's Impression of the TPF Optical Coronagraph (TPF-C) and the TPF Formation-Flying mid-IR Interferometer (TPF-I)

Research Opportunities for Planetary Scientists

There are opportunities for planetary scientists to participate in NASA's program to understand extrasolar planetary systems. The annual NASA *Research Opportunities in Space and Earth Science* (ROSES) proposal call may be of interest to the AAS/DPS community, and specifically the calls for *Origins of Solar Systems*, and *Terrestrial Planet Finder / Foundation Science*.

As a guide to the kind of research currently being supported, abstracts of the selected proposals from 2004 and 2005 are ***available as handouts*** (*at this poster*). Also available on the NASA ROSES Website: http://research.hq.nasa.gov/

SIM PlanetQuest will have an open call for all categories of proposals in 2007: http://sim.jpl.nasa.gov

This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.