RoPACS Mid-Year Workshop

Preparing for Cosmic Vision

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Munich, Germany

Reminder of what I do...

- Direct Exoplanet Imaging with current technology
- Design studies at Astrium for potential future space missions
- Work in Paris on an end-to-end simulation of space-based planet imaging

Outline

- Exoplanet Roadmap
- Space Mission Concepts
- My Current Contributions
- Comments And Future Work

EPRAT--Exoplanet Roadmap Advisory Team

- Expert advisory team appointed by ESA
- Aim to advise on the best scientific and technological roadmap to achieve the characterisation of terrestrial exoplanets
- Final roadmap to be delivered to ESA by end of May 2010 and published by July 2010
- Draft version of roadmap document has been presented and the community was given a chance to comment in last workshop (7th & 8th April)
- Emphasis on the science of ExoPlanets and the methods of detection and characterisation

After Side Meetings With Astrium...

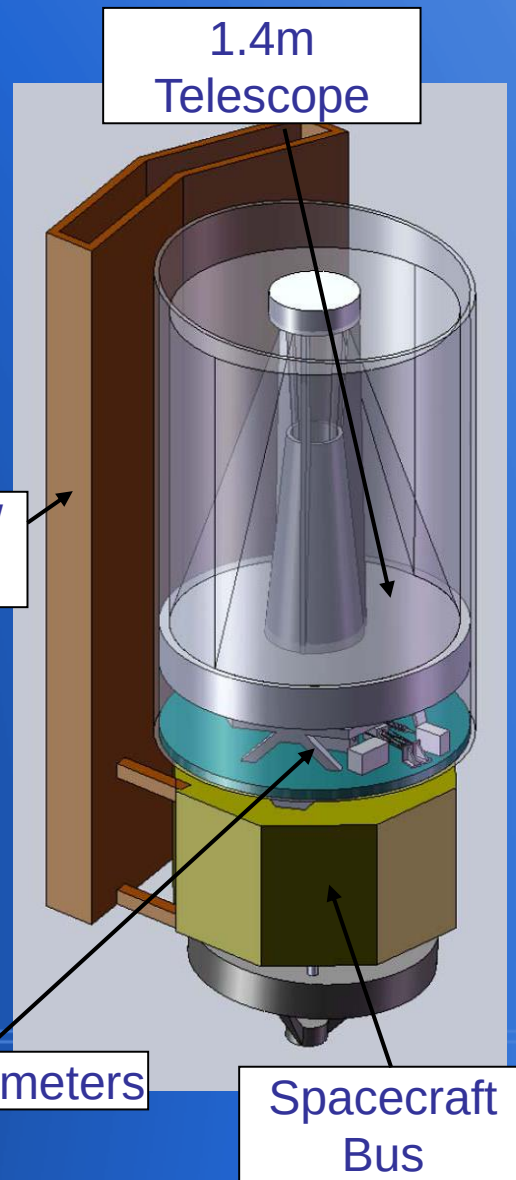
- Roadmap lacked technology and technology development discussions
- ESA weights technological feasibility more than backing by the scientific community when choosing to sponsor a space mission
- EPRAT was made aware of these comments and will hopefully incorporate them into their final draft.

Space Mission Concepts

THESIS-Transiting Habitable-Zone ExoPlanet Spectroscopy Infrared Spacecraft

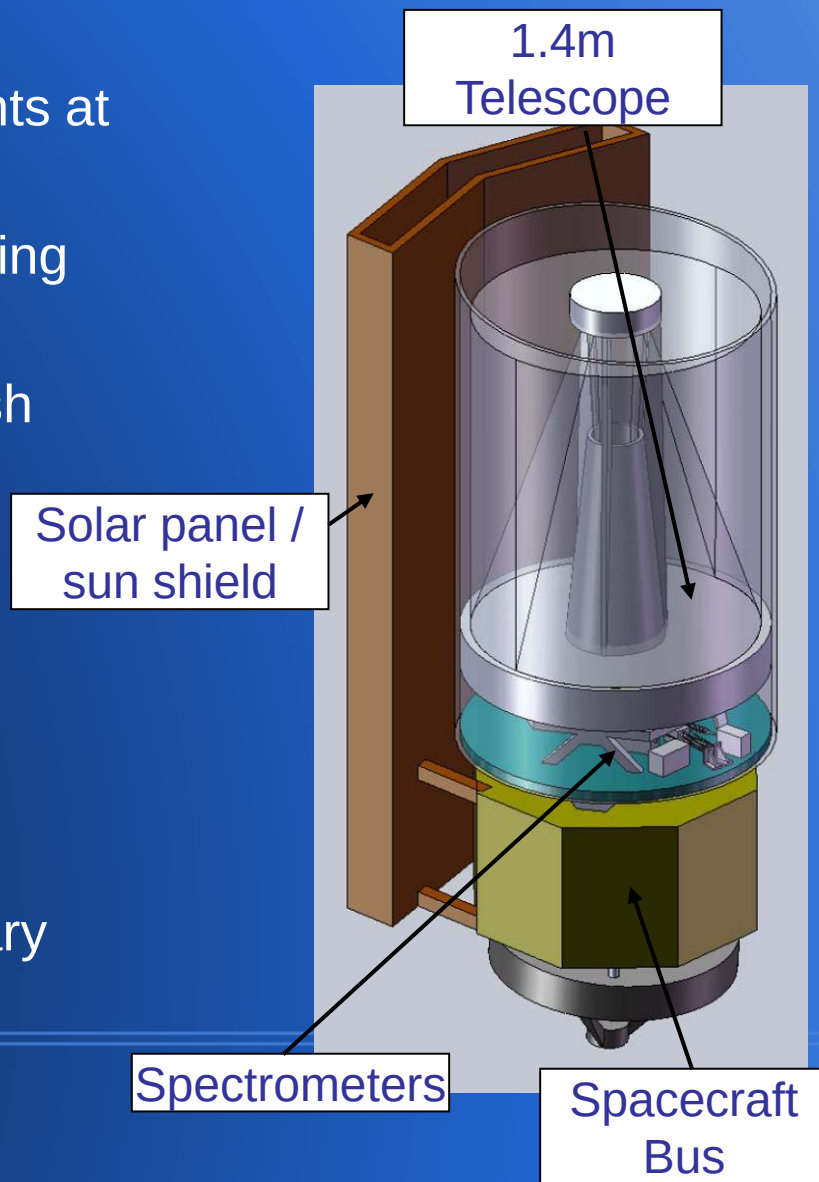
3 key science questions:

- What are the conditions, composition and chemistry of exoplanet atmospheres
- How do dynamics affect atmospheric composition and chemistry
- Are biologically important molecules present in habitable-zone rocky or ocean worlds



THESIS

- Measurements to be made:
  - Primary and secondary eclipse events at modest resolution spectra (R~2000)
  - Light curve measurements of transiting and non-transiting exoplanets
  - Repeated measurements to establish short-term and long-term variability
- 1.4m telescope
- 2-14μm wavelength range
  - Visible to mid-infrared
- High ‘stability’ needed
  - Over hours for primary and secondary transits
  - Over days, weeks, months for non-transiting planets



SEE-COAST: Super Earth Explorer

- Coronograph Off-Axis Space Telescope
  - Visible wavelengths
- Direct imaging of ExoPlanets down to 2.5 Earth Radii
- Ultra-smooth mirror needed
  - At least 1.5m diameter mirror
  - Wavefront error λ/200 rms @ 633 nm
  - Active correction required
    - i.e. Deformable Mirrors/Active Mirror Optics
- Low resolution spectroscopy and polarimetry

SEE-COAST

Key technologies:

- Achromatic coronagraphs
- Integral Field Spectrograph
- Differential Polarimetry
- Adaptive optics / Deformable Mirrors

- Major issue for both of these missions:

Where are the targets?

My Current Contributions:

- How many candidates can we expect to find that could be observed by these proposed missions?

Simulations

- Take a subset of the local stellar population that could host observable planets for these space missions
- Simulate a planetary population based on current exoplanet catalogue

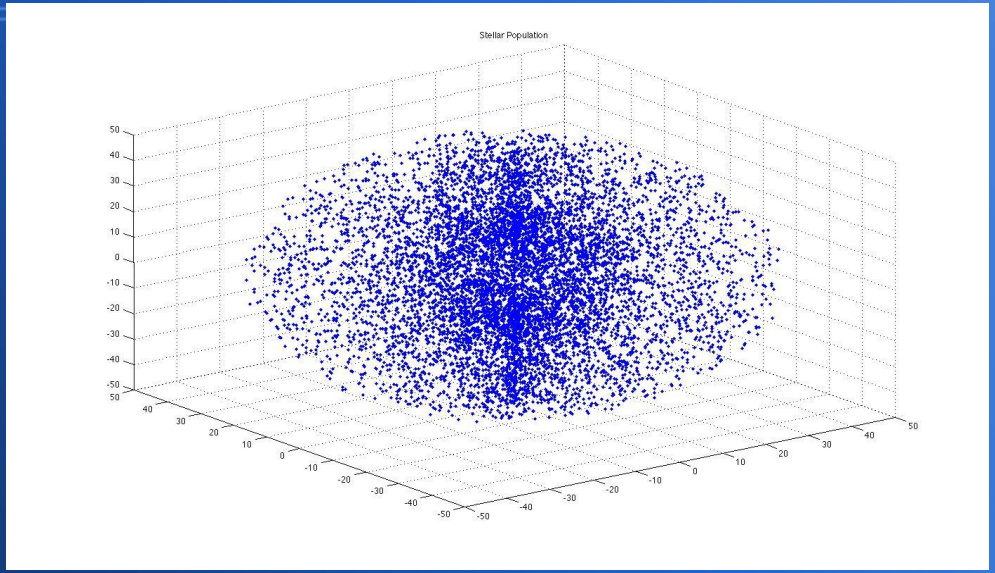
Assumptions:

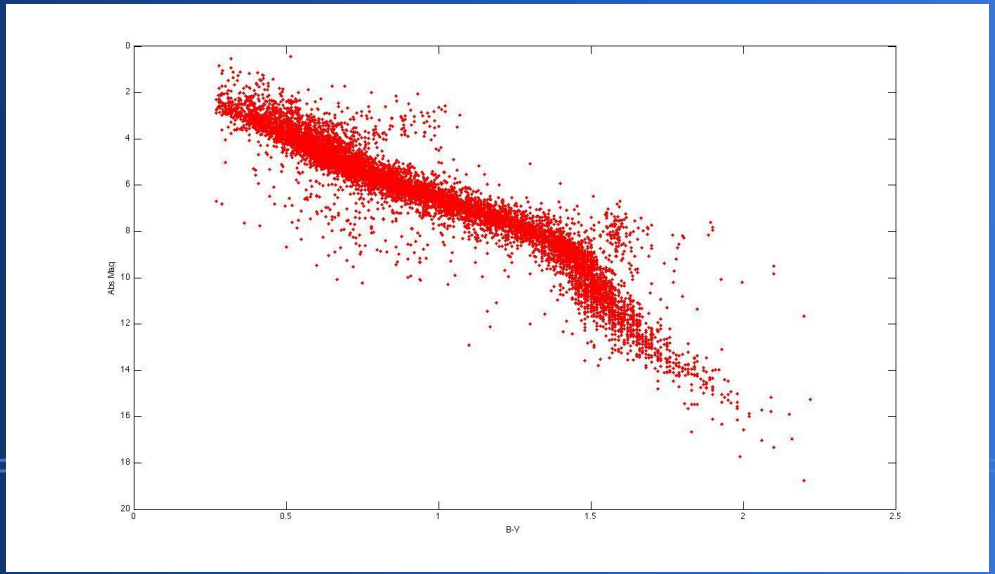
  - Every star has a planet
  - Only one planet per star
  - Circular orbits

- Calculate the observability of the resulting planet population
  - Transiting probability, depth
  - Radial Velocities

Stellar Population

- ~ 9000 Stars taken from Gliese and Hipparcos
- Distance cut off at 50 PC
- Spectral type KFM with no significant deviations from the main sequence

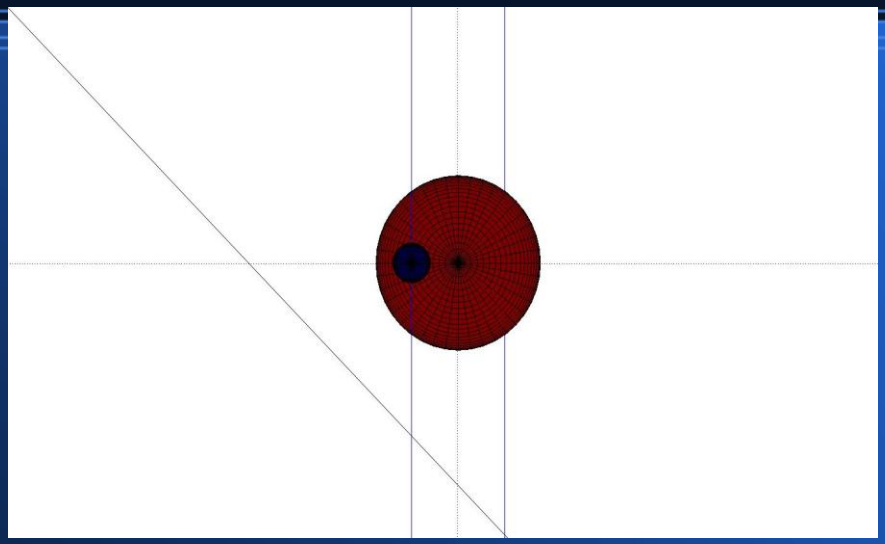




Planet Properties

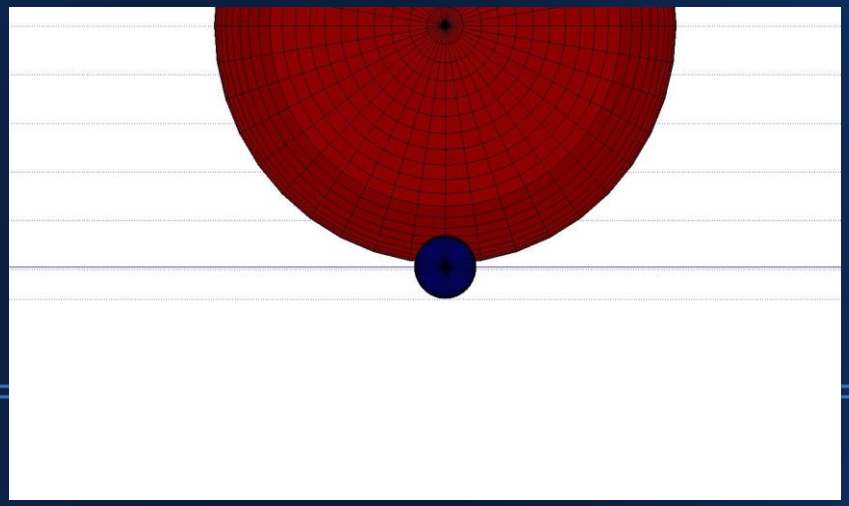
- Current empirical properties of exoplanets used for simulated population
  - Mass – Power law fit
  - Radius (theoretical: Fortney et al 2007)
  - Semi-major axis – Power law fit
  - Random inclination assigned

Simulated Transits

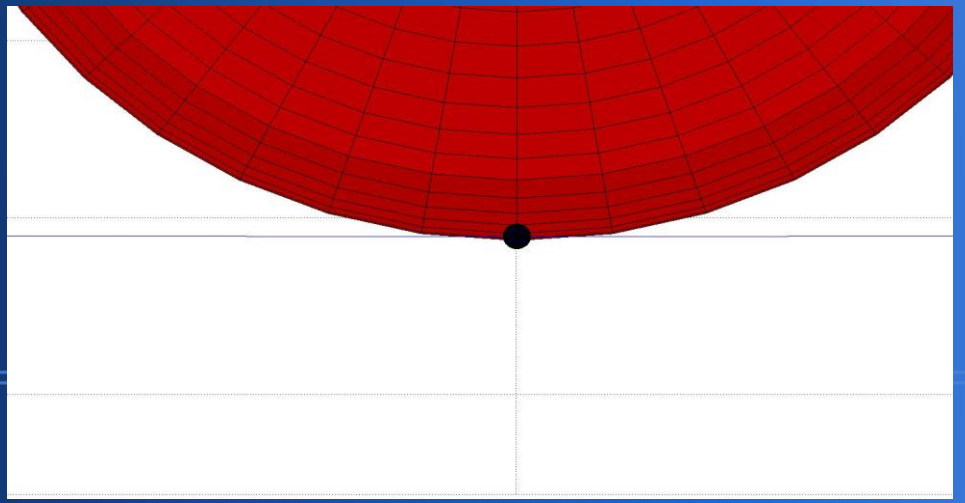


Full

Shallow



Deep



(Very) Preliminary Results

- Out of 9053 planets, 566 transit (either full, deep, or partial)
- Only 6 produced a transit depth of 0.5% or greater

Future work

- Fine tune planet properties
- Add RV detection capabilities based on current state of the art tech

Thanks

BACKUP

EP-RAT