

Combined-Light Photometry on Orbiting Platforms

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What is Combined Light?

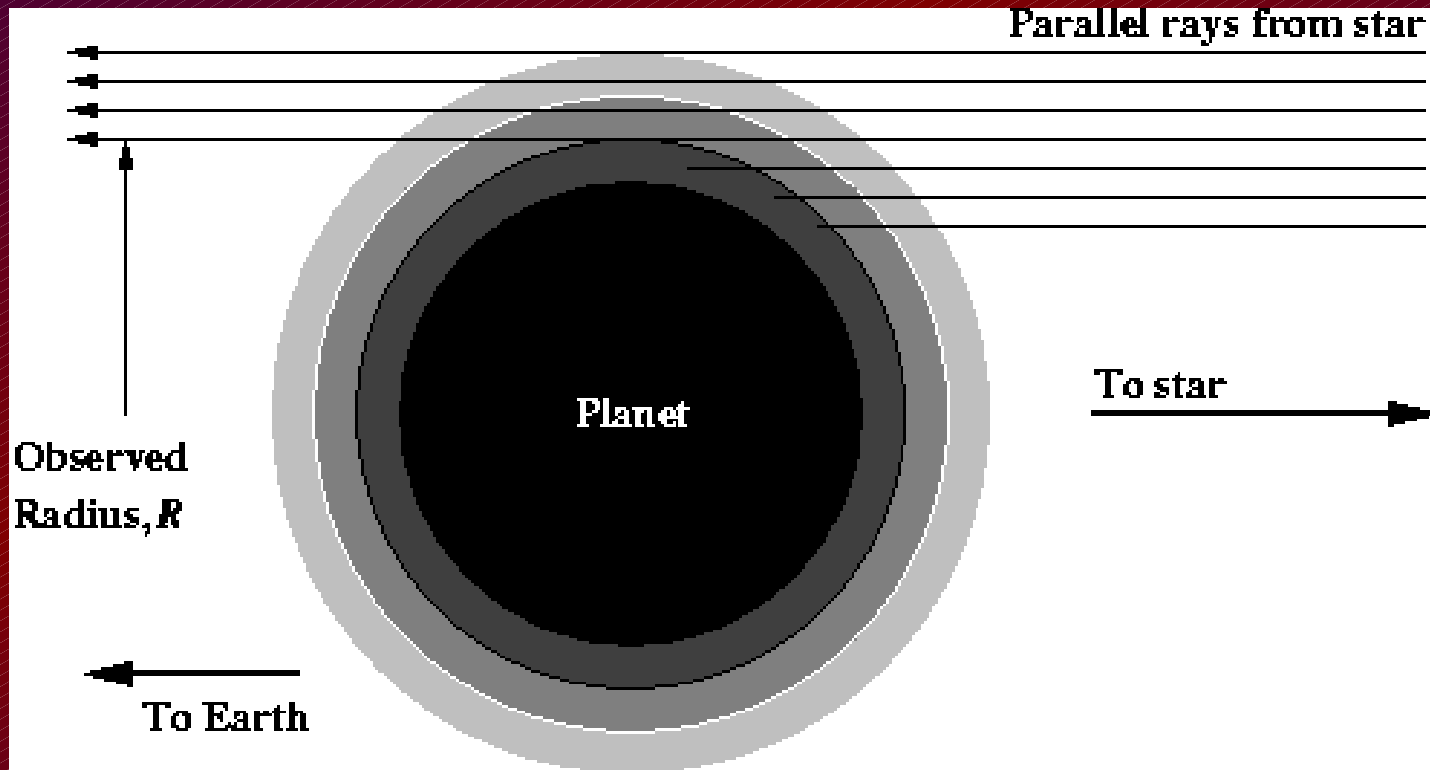
- Light of star and planet in one PSF
- No suppression of star
- No angular separation of star and planet
- Doing it now, no technology development
- Transits
- Eclipses
- Orbital modulation
- Just talking about photometry in this talk

Transits in Front of Star

- Discovery - $\sim 0.1 - 2\%$ dip, periodic (2000)
 - Optical (best instruments, star peaks, low bg)
 - $R_p, i \Rightarrow M_p, \rho, g$
 - Timeframe: 3 – 10 orbits, need RV followup
- Any λ
 - $R_p(\lambda) \Rightarrow$ Spectrum constraints, 0.1 - 0.01%
 - Timeframe: several \times 5-10 hours

Transit Radius

- Imagine a gas planet in front of its star
- The “radius” we see is the altitude where light can penetrate the atmosphere



Eclipses Behind Star

- Direct detection of planetary photons (2005)
- Thermal emission or reflected light
- 0.01 – 0.3 % in IR, 10^{-6} – 10^{-10} in visible
- Timeframe: several \times 5-10 hours
- Spectrum constraints

Orbital Modulation

- Emission/reflection variation around orbit (2006)
- 0.001 – 0.03% in IR, 10^{-7} – 10^{-11} in visible
- Weather, cloud, chemistry maps (hard to disentangle)
- Redistribution efficiency

Requirements

- Stability – would love to do Spitzer right!
 - Time (constant baseline)
 - Space (smooth response across pixel)
 - Time (obs at start of mission same as at end)
 - Calibrator stars?
- Pointing
 - Spread light across many pixels, relax req.
 - 5 hours – few weeks per stare
 - Interruptions not great – CVZ from LEO

Requirements

- Thermal – radiation from Earth, sun
 - Hide behind solar panel
 - Sun-sync polar and 2 panels?
 - Wrap-around panels with standoffs?
 - Sun-sync lunar orbit? L1/L2
- Data: GB per dataset

Low-Cost Rides

- Have heard many promises!
- Questionable for > 1 ton or higher than LEO
- LEO on ~Falcon: 150 kg payload, small scope
- Hard to do large aperture or cooled IR
- Great for discovery, TTV
- All-sky, bright-star Kepler with fish-eye lenses?
- Autonomous, uniscope Mini-TESSes?
- Compete with 8-m scope on ground: Must look for *tiny* planets

Barnacle

- GOLD – <http://fsi.ucf.edu/GOLD/>
- On comsat, stares at Earth
- Cannot torque satellite (cannot point)
- Could look at CVZ
- Use flat mirror, stationary scope
- Weight limit...
- ~\$15M for launch and platform

ISS

- Probably good if can get there cheap
- Ride-along on supply flight?
- Must be light?
- Else LV is expensive, prefer LEO?
- Must deal with vibrations (pointing)
- Could be maintained by astronauts (so what?)

THESIS Photometry Descope

- Make THESIS cheap by doing just photometry
- Seems like a poor use of funds...

EpoXI, MOST Lessons

- Not finding anything...

Pay to Extend HST?

- Join with other science to extend HST operations
- Likely good for spectroscopy
- Not cost-effective for photometry