Target Selection for the LBTI Hunt for Observable Signatures of Terrestrial Planetary Systems

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INTRODUCTION

The Hunt for Observable Signatures of Terrestrial planetary Systems (HOSTS) on the Large Binocular Telescope Interferometer (LBTI) will survey nearby stars for faint exozodiacal dust (exozodi). This warm circumstellar dust, such as that found in the vicinity of the Earth in our own system, is generated in asteroidal collisions and cometary breakups.

Current exozodi detection limits from ground-based interferometers (e.g. KIN) and space-based photometry are at best 150 − 500 times our system's level, aka. 150 − 500 zodi. LBTI-HOSTS will be the first survey capable of measuring exozodi at the 10 zodi level (3σ).

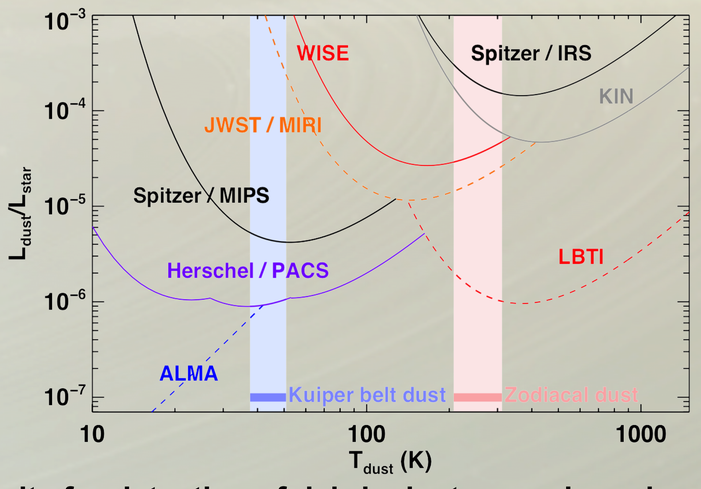

Figure 1: Sensitivity limits for detection of debris dust around nearby Sun-like stars (3σ). [Roberge et al., 2012]

Exozodi of this brightness would be the major source of astrophysical noise for a future space telescope aimed at direct imaging and spectroscopy of habitable zone (HZ) terrestrial planets (aka. exoEarths). The time required to image a planet with some SNR increases linearly with exozodi surface brightness.

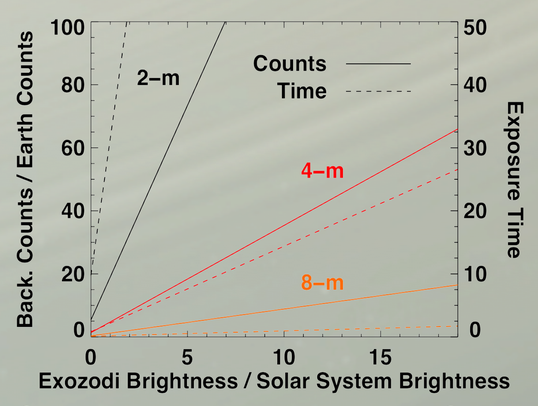

Figure 2: Impact of exozodi on direct imaging of exoEarths. [Roberge et al., 2012]

Detections of warm dust will also reveal new information about planetary system architectures and evolution. Asteroid belts undergoing steady state collisions should grind themselves down in much less time than the Gyr ages of nearby stars. So, warm debris disks may signal late cometary influxes or stochastic collisional events (e.g. Kennedy & Wyatt 2013).

SELECTION PROCESS

Science questions

1. What is the exozodi luminosity function for nearby stars?
   - Observe statistically significant sample of stars
2. Does the level of cold dust correlate with exozodi level?
   - Observe stars with known cold dust
3. How does the exozodi level vary with stellar type?
   - Observe stars w/ range of spectral types

Starting star catalogs: Hipparcos 30 pc sample and Unbiased Nearby Stars sample (Phillips et al. 2010)

We exclude binaries of three types on observational and astrophysical grounds:

1. Any visual binary < 1.”5. At these separations, the companion could degrade the adaptive optics system’s ability to close its loop and/or achieve excellent wavefront correction
2. Any spectroscopic binary. The companion flux is likely to leak into the null and prevent sensitive dust detection.
3. Any physical binary with separation < 100 AU. Disk evolution studies show that binaries of this separation range result in reduced disk mass and faster disk dissipation; we might expect these have lower planet formation efficiency. This exclusion includes binaries whose orbits are not determined but that have projected separations < 100 AU.

Targets must be > 1 Jy at N'-band (broad 10.2 μm) filter for optimal LBTI sensitivity.

Targets must have inner habitable zone distances probed by the LBTI null, i.e. ≥ 60 mas.

STRATEGY

1. Observe actual stars that would be good targets for a future exoEarth direct imaging mission (**“Mission Driven Selection”**)

Sweet spot for an optical planet imager aimed at exoEarths is **G-K stars**; since 1) for a HZ planet of a certain size and type, the planet/star brightness ratio goes as $(L_\star)^{-1/2}$ and 2) the size of the habitable zone goes as $(L_\star)^{1/2}$.

A-type stars have poor planet/star brightness ratios, M-type stars have small habitable zones.

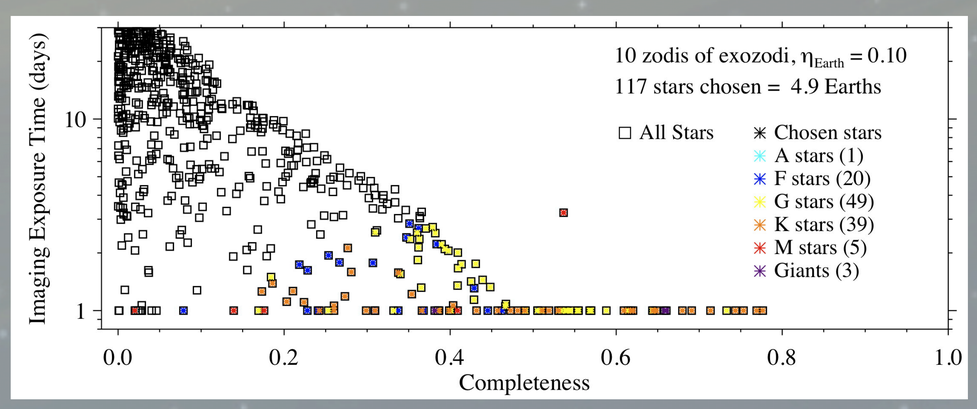

Figure 3: The stars chosen to maximize the yield of Earth-analog planets observed with a 4-meter optical direct imaging mission. [Turnbull et al., 2012]

2. Observe a sample of stars that enable sensible extrapolations for stars that cannot be observed with LBTI (**“Sensitivity Driven Selection”**)

Sweet spot for LBTI sensitivity to exozodi is **A-F stars** because they have larger habitable zones and higher $F_{disk}/F_\star$ values.

FINAL SAMPLE

- Early-type: 13 A-type, 13 F0-F4
- Sun-like: 20 F5-F8, 11 G-type, 18 K-type
- Maximum distance = 27 pc
- Expected LBTI exozodi sensitivity < 30 zodis for all stars

The LBTI HOSTS program will observe ~50 stars out of this sample. The survey will begin Spring 2014 and continue for 4 years. Targets will be prioritized by the science team to achieve the scientific goals.