OBSERVING REQUEST
University of Arizona Observatories

Year: 2014 **Term:** Jul–Dec **Proposal type:** long-term⋆ **Proposal ID:** L

LBTI HOSTS: The Hunt for Observable Signatures of Terrestrial Systems

P.I.: Phil Hinz (SO; *phinz@as.arizona.edu*;)

CoI(s): Denis Defrère (SO), Andy Skemer (SO), Vanessa Bailey⋆ (SO), Bill Hoffmann (SO), George Rieke (SO), Andras Gaspar (SO), Kate Su (SO), LBTI HOSTS team (various)

Abstract of Scientific Justification

Debris dust in the habitable zones of stars - otherwise known as exozodiacal dust - comes from extrasolar asteroids and comets and is thus an expected part of a planetary system. Background flux from the Solar Systems zodiacal dust and the exozodiacal dust in the target system is likely to be the largest source of astrophysical noise in direct observations of terrestrial planets in the habitable zones of nearby stars. LBTI, by orders-of-magnitude, is the most sensitive system for detecting exozodiacal dust around nearby stars. The HOSTS program will observe 60 nearby stars to construct a luminosity function of exozodiacal emission. The results of this work will be critical for planning future space-based direct imaging missions.

Summary of observing runs requested for this project

								Scheduling		Sharing	
Run	Telescope	Cage	Instrument	PI	AO	Nights	Moon	Optimal	Acceptable	Poss.	Adv.
1	LBT		LBTI	*	*	7	bright	Feb. -Jun.	Feb. -Jun.	yes	yes

Scheduling constraints and unusable dates *(up to 4 lines)*: HOSTS nights are best scheduled to share nights with LBTI science requests. We request the time be scheduled into at least two blocks separated by at least a month.

no text past this line

A ⋆ appended to the proposal type indicates a continuation proposal; a ⋆ appended to the name of a proposer indicates the proposer is a (graduate) student; a proposer whose name is underlined is certified on the proposed telescope/instrument combination; if a ∗ appears within the PI or AO box in the observations summary table, the instrument is a PI instrument and/or Adaptive Optics are requested – signatures are required on the next page.

Target list (attach list if longer than 26 objects)

#	Object	RA	Dec	mag / color / type / redshift / comment / etc.
1	A paper describing the HOSTS target list (Weinberger et al. submitted) is available upon request.			

Approval for Instrument Use from PI: ______________________________

*(have instrument PI signature appear on, or attach PI e-mail to, **all** copies)*

Graduate students *(provide the following information for **each** student named as PI or CoI on the cover page. Have the advisor's signature(s) appear on **all** submitted copies)*

Student's Name	Advisor's Name	Advisor's Signature	2nd-yr	Thesis
Vanessa Bailey	Phil Hinz		no	no

Scientific Justification

Debris dust in the habitable zones of stars - otherwise known as exozodiacal dust - comes from extrasolar asteroids and comets and is thus an expected part of a planetary system. Background flux from the Solar System's zodiacal dust and the exozodiacal dust in the target system is likely to be the largest source of astrophysical noise in direct observations of terrestrial planets in the habitable zones of nearby stars.

For the future of exoplanet imaging, the Astro2010 decadal report lists, as a critical step, the need to *"characterize the level of zodiacal light present so as to determine, in a statistical sense if not for individual prime targets, at what level starlight scattered from dust will hamper planet detection."* As shown in Figure 1, LBTI is orders-of-magnitude more sensitive to exozodiacal emission than any other instrument, past or present. NASA has funded the development of LBTI and a survey of nearby stars (HOSTS) as part of its strategic plan to build a flagship exo-earth imager.

The HOSTS survey, which is led by the University of Arizona, is completing the commissioning of LBTI as a nulling interferometer, capable of suppressing light from a star and spatially resolving faint exozodi emission. HOSTS has already imaged a bright zodiacal disk around the nearby F-star, η CrV (see Figure 2; Defrère et al. submitted), and other discoveries around well-known cold debris disk host stars are in the process of being confirmed.

In 2014B, the LBTI instrument team will complete commissioning, and the exozodi survey will begin in 2015A. Here we request 7 nights to begin surveying our prime sample, which comprises nearby stars that are likely to be targeted by any implementation of a terrestrial planet imager (Weinberger et al. submitted). We are reserving two of these nights as contingency for commissioning work being carried out in 2014B. In the remaining 5 nights, HOSTS will determine the level of exozodiacal emission 15 stars at a precision of 1-σ=3-6 zodi, a level which, for the first time, is good enough to truly guide planet imaging mission design.

Technical Status: The phase loop subsystem of LBTI is being commissioned in 2014B. Initial results in 2014A with a non-optimized system have demonstrated an RMS of 1 μm. This has resulted in nulling uncertainties as good as 0.18% (70 zodies). Lab testing over the summer has demonstrated the ability to remove vibrations at 12 Hz (the main source of phase variations) by 3-5 times. The four separate commissioning tests in 2014B are planned to optimize the phase correction and refine the observations such that repeatable nulling measurements are achieved with uncertainties in the range of 0.01%.

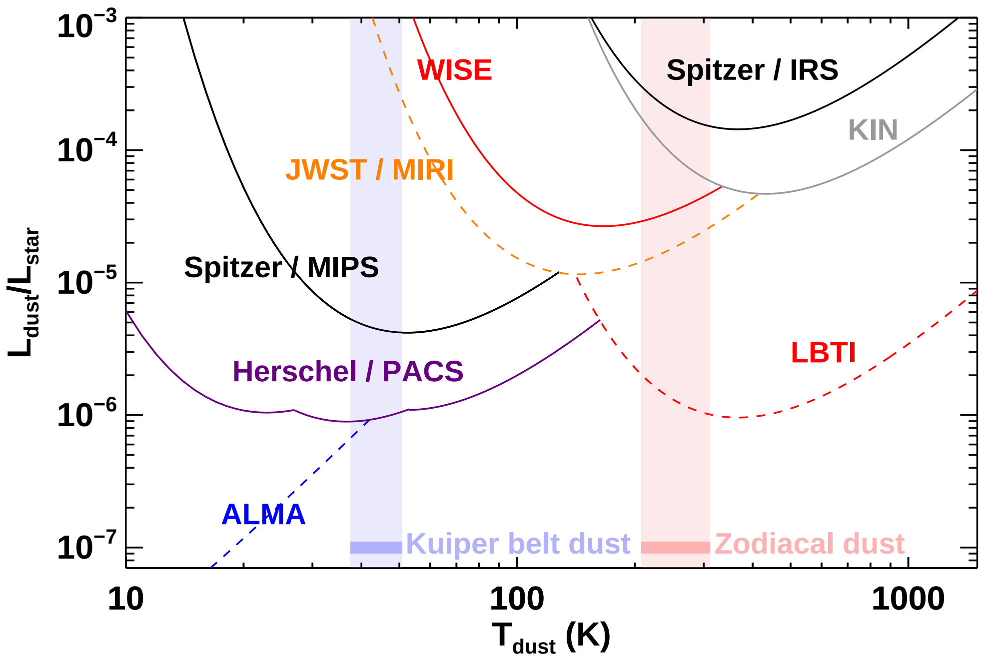

Figure 1: A variety of instruments have been used to study cold and warm debris disks (labeled 'Kuiper Belt Dust' and 'Zodiacal Dust' respectively). LBTI is orders-of-magnitude more sensitive to exozodiacal emission than any other instrument, past or present. By characterizing the level of exozodiacal light around nearby stars, HOSTS will determine the impact of exozodi background emission on future exoplanet imaging missions. *Figure from Roberge et al. 2012.*

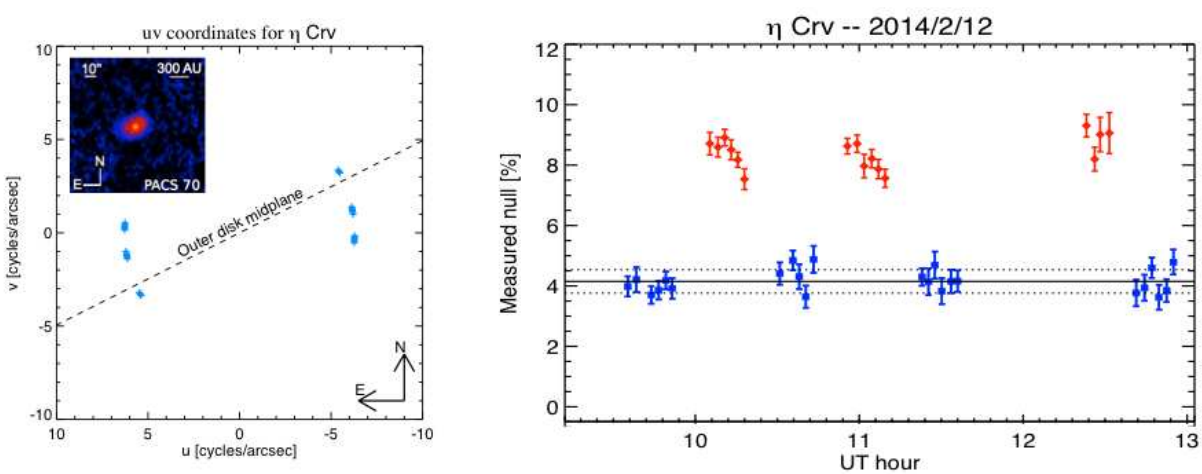

Figure 2: First detection of warm exozodiacal dust around a star with LBTI (Defrère et al. submitted to ApJ). The right image shows the null on the science object (red diamonds) compared to the calibrator stars (blue squares). The left figure shows the corresponding u-v coordinates which are centered around the major axis of the cold disk detected by HERSCHEL (see inset). The resolved warm dust disk was found to have an excess at the 4.54%+/-0.35% level. Modeling of these data constrains the disk to be located at approximately 0.7-1.0 AU from the central star.

Experimental Design & Technical Description *Describe your overall observational program. How will these observations contribute toward the accomplishment of the goals outlined in the science justification? If you've requested long-term status, justify why this is necessary for successful completion of the science.* ***(up to one page)***

The observations will follow our typical sequence for nulling interferometry at N' band, alternating science targets and calibrators as follows: CAL1-SCI-CAL2-SCI-CAL3-SCI-CAL1. Each observation will last 20 to 25 min including overheads. The calibrator stars will be chosen using the SearchCal software developed by the JMMC (Bonneau et al. 2011). We thus expect to require $\sim$3 hours of clock time per object. We allocate another 20 minutes per sequence for setup. This will result in 3 stars per night of observation. We thus assume we can observe up to 15 stars for the requested time (assuming two nights are needed for remaining commissioning tasks) in 2015A, assuming clear, usable conditions.

Summary of Time Requested and Awarded *The TAC needs to understand the scope of this project — (1) tell us how many UAO nights you've already had for this project, how many you request this time, and (a good guess of) how many you need to complete the project; (2) if a substantial amount of observing for this project comes from non-UAO telescopes, tell us about that observing, and how the UAO part fits in; (3) if you are collaborating with people who have telescopes, especially if you are part of a large collaboration, tell us who is leading the project, and how UAO time and your participation fit in. (**up to one page**)*

A contractual agreement between Arizona and NASA is in place to provide up to 20 nights per year of time on the LBT for up to nine years, starting in FY2011. The agreement has resulted in NASA supporting the fabrication and observational support of the LBTI. The original agreement allowed for 20 nights of commissioning, and 160 nights spread over eight years, 60 of which would be devoted to a key program of detecting exozodiacal dust, and 100 of which would be available to the general community for competed observational proposals.

The above agreement serves as a ceiling for the number of nights obligated to NASA. More recently, NASA has indicated interest in carrying out only the key program (61 nights) and not implementing guest access. The actual time allocated to the LBTI program is dependent on yearly funding available. For FY2011 (October 2010-September 2011), 9 nights were funded, and allocated. For FY 2012, 11 nights were funded. These two years comprised NASA's commitment to twenty nights of commissioning time for the instrument.

The HOSTS program: NASA has committed funds to allocate 61 total nights for the HOSTS program in FY13-17. Nine nights in FY13 were used to carry out commissioning tasks. Due to telescope issues, only four nights were executed in FY14. The current request (7 nights) would result in a total of 18 nights requested in FY15. We expect to request 7-8 nights per semester for 2015B-2017A to complete the survey (30 nights for a total of 61 over FY13-17, per the agreement).

Previous Use of Steward Facilities *List **all** allocations of telescope time for the present project and allocations for other projects on facilities available through UAO during the past 2 years, together with the current status of the data (cite publications where appropriate). Mark those allocations related to the present proposal (i.e, precede text with* `\related` *command). (**up to one page**)*

Three HOSTS papers have recently been submitted to ApJ:

- ⋆ Defrère et al. *First-light LBT Nulling Interferometric Observations: Warm Exozodiacal Dust Resolved within a few AU of Eta Crv*
- ⋆ Kennedy et al. *Exo-zodi Modeling for the Large Binocular Telescope Interferometer*
- ⋆ Weinberger et al. *Target Selection for the LBTI Exozodi Key Science Program*

Other LBTI programs, primarily LEECH and LMIRCam imaging, account for 9 refereed science publications (+2 submitted) in the past 2 years.