The HOSTS survey:
Exozodiacal dust measurements for 30 stars

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S. Ertel, D. Defrère, P. Hinz (PI), B. Mennesson, G. Kennedy, the HOSTS team, et al.
Astronomical Journal, in press

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The zodiacal dust / Why do we care about exozodis?
The zodiacal dust

- Dust inside a few AU
- Power law surface density ($\alpha \sim -0.5$) (Kimura & Mann 1998, Hahn et al. 2002)
- T: few 100K to 2000K (Kimura & Mann 1998, Hahn et al. 2002)
- Comet evaporation (Nesvorny et al. 2010)
  asteroid collision & P-R drag (Dermott et al. 2002)
- Complex local structure (planetary interaction, local dust creation)

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Why do we care?

• Most luminous component of planetary Systems after star
• Gives insight into architecture and dynamics in the innermost regions (near habitable zone)
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- Most luminous component of planetary Systems after star
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Why do we care?

- Dust causes confusion for future exo-Earth imaging missions!

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**Telescope Size (m) for Given Yield and Exozodi level**

<table>
<thead>
<tr>
<th>Exoplanet Yield</th>
<th>EZ = 5</th>
<th>EZ = 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Earths</td>
<td>5m</td>
<td>8m</td>
</tr>
<tr>
<td>30 Earths</td>
<td>9m</td>
<td>13m</td>
</tr>
</tbody>
</table>

Stark et al. (2015)
Observing exo-zodiacal dust
Observing exo-zodiacal dust

The challenge:

- ~HZ dust, ~2500 x Solar system!

• Zodi levels < 1000 x Solar system not detectable with photometry or spectroscopy
• Need to spatially disentangle dust emission from star light
• 1 AU at 10 pc = 0.1 arcsec, needs (nulling) interferometry!

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Observing exo-zodiacal dust

The LBTI/HOSTS program

Large Binocular Telescope (LBT) on Mt Graham, Arizona
Observing exo-zodiacal dust

The LBTI/HOSTS program

- NASA funded project
- Develop the Large Binocular Telescope Interferometer (LBTI)
- Carry out the Hunt for Observable Signatures of Terrestrial planetary Systems (HOSTS)

Detection rates:
- WISE: 22 of 24174 (0.09%)
- KIN: 5 of 44 (11%)
- LBTI: 5 of 28 (18%), ongoing
HOSTS results (a brief overview!)
• Measurements & errors well behaved
• 4 new detections: First three around Sun-like stars, first two around stars without cold dust
• Detections: β UMa, β Leo, η Crv, δ UMa, θ Boo, 110 Her, ε Eri
Detection statistics:

- Probability that stars with and without cold dust have the same incidence rate: $p = 0.03$

- Same incidence rate for Sun-like and early type stars comes at ~4x lower sensitivity around Sun-like stars
HOSTS results

Detection statistics:

- 2 of 12
- 3 of 16
- 3 of 5
- 2 of 23

(P Kennedy & Piette 2015)

Poynting-Robertson drag for most systems with outer belts?

(Kennedy & Piette 2015)
HOSTS results

Median zodi level:

Upper limits on median zodi level (95% confidence, assuming lognormal distribution):

- 13 zodis for all stars
- 25 zodis for Sun-like stars
HOSTS results

Median zodi level:

Upper limits on median zodi level:
(95% confidence, assuming lognormal distribution):

• 13 zodis for all stars
• 26 zodis for Sun-like stars

Exo-Earth imaging generally possible!
Exozodi luminosity function:

- LBTI data suggest **steeper** luminosity function than in-situ dust production model (Kennedy & Wyatt, 2013)

- At low dust levels **comet evaporation** (Marboeuf et al., 2016) or **Poynting-Robertson drag** (Kennedy & Piette, 2015) may contribute?
Hosts results

No detection around Vega!!

- Upper limit of 44 zodis (3 sigma) between ~0.5 AU and ~2 AU, 150 zodis between ~0.5 AU and ~5 AU, HZ at ~7 AU
- Large amounts of cold dust at 14+ AU (e.g., Aumann et al. 1984, Su et al. 2013) and hot dust (>1000 K) (Absil et al. 2006, Defrère et al. 2011)
- Why no warm dust?! Poynting-Robertson drag should fill the habitable zone (Kennedy & Piette, 2015). Planets?
Thank you very much!

Want to know more?
Weinberger et al. (2015): Sample selection
Kennedy et al. (2015): Modeling
Defrère et al. (2015): η Crv
Ertel et al. (AJ, in press): First survey results
Hinz et al. (in prep): β Leo
More to come!

Or ask for a colloquium talk!
Extra: Nulling interferometry
Extra: Nulling interferometry

180 deg phase shift
Extra: Nulling interferometry

- 180 deg phase shift
- Optical path delay
Extra: Nulling interferometry