An AO Survey of the First Sample of Debris Disk Stars from WISE

Sasha Hinkley
Exeter University
September 10th 2014

Collaborators:
Dimitri Mawet (ESO), Karl Stapelfeldt (GSFC), Deborah Padgett (GSFC), Farisa Morales (JPL), Adam Kraus (UT), Mike Ireland (AAO), John Carpenter (Caltech), Eugene Serabyn (JPL), Bertrand Mennesson (JPL), Jonas Kuhn (JPL)
Overview


2. Other Debris Disk work.
Exoplanet Imaging in 2014

- β Pictoris
- Fomalhaut
- GJ 504 (Subaru)
- HD 95086 (VLT)
- HD 106906

DEBRIS DISK

HR 8799

H₂, NICI
Does Debris Signal Planetary Systems?

- Bright dust may indicate planetesimal stirring by larger bodies.

- Debris Disks are sculpted by planets: \( \beta \) Pic, HR 8799, Fomalhaut.

- 24 \( \mu m \) excess reveals stellar youth.
Warm Debris Dust Traces Stellar Youth: The Trend for A-type Stars

Rieke et al. (2005)
Wyatt et al. (2007)
High Contrast Imaging Follow-up to WISE Debris Disks

- WISE all sky survey: 3, 5, 12, 22 µm.
- Hundreds of new 22 µm excess stars (e.g. Patel et al 2014)
Overview


2. Upcoming Debris Disk work.
A VLT/Keck Survey of Newly Identified Debris Disk Stars

Collaborators:

Sasha Hinkley (Exeter)
Dimitri Mawet (ESO),
Farisa Morales (JPL),
Karl Stapelfeldt (GSFC),
Deborah Padgett (GSFC),
Eugene Serabyn (JPL),
Bertrand Mennesson (JPL),
Jonas Kuhn (JPL)
### High Contrast Surveys for Exoplanets

<table>
<thead>
<tr>
<th>Survey</th>
<th>Telescope</th>
<th>Number of Stars</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPI/SPHERE</td>
<td>Gemini-S, VLT</td>
<td>~600</td>
</tr>
<tr>
<td>SEEDS</td>
<td>Subaru</td>
<td>~300</td>
</tr>
<tr>
<td><strong>This Survey</strong></td>
<td>Keck/VLT</td>
<td><strong>262</strong></td>
</tr>
<tr>
<td>NICI</td>
<td>Gemini-S</td>
<td>218</td>
</tr>
<tr>
<td>IDPS</td>
<td>Gemini/VLT</td>
<td>~200</td>
</tr>
<tr>
<td>LEECH</td>
<td>LBT</td>
<td>135</td>
</tr>
<tr>
<td>NACO Large Program</td>
<td>VLT</td>
<td>86</td>
</tr>
</tbody>
</table>
Survey Specifics

WISE Infrared Colors

Number

Spectral Type

0 0.5 1 1.5 2
[3.6] - [22] μm

HR 8799
Survey Specifics

The figure shows the distribution of stars by spectral type and distance. The x-axis represents spectral types (A0, F0, G0, K0, M0) and distance in parsecs (pc). The y-axis represents the number of stars. The histogram on the left indicates a concentration of stars in the A0 spectral type, while the right histogram shows a broad distribution with a peak near 50 pc.
Survey Performance: 5σ K-band Contrast at 1"

SEEDS Debris Disk Survey
Janson et al (2013)
Candidate Companions

103 Candidate Companions to Date
Candidate Companions

All Galactic latitudes

Contrast

Radius (arcsec)

HR 8799
Candidate Companions
Candidates from Keck
Overview


2. Other Debris Disk work.
HR 8799

Marois et al. 2010
The HR 8799 Debris Disk

Planetesimal belt (45 K): 90-300 AU

Inner warm belt (150 K): 6-15 AU

Inner clearing within 6 AU

100 AU
The Inner 10 AU of HR 8799

Planetesimal belt (45 K): 90-300 AU

Inner warm belt (150 K): 6-15 AU

Marois et al. 2010
Keck L-band Sparse Aperture Masking

- Several small apertures
- No coronagraph.
- See work by: Lacour/Gauchet + Absil

Extremely small resolution: 
(10-300 milliarcsec)

Modest contrast: 
($10^2 - 10^3$)
Young Planets Are Bright

Stars

Burrows et al. (1997)

Luminosity ($L_\odot$)

-10
-8
-6
-4
-2
10

Age

10 Myr
100 Myr
1 Gyr
10 Gyr

Planets

Brown dwarfs

11 M_\odot
73 M_\odot
211 M_\odot

1.0 $M_\odot$
0.5 $M_\odot$

Young Planets Are Bright
The Inner 10 AU of HR 8799
Hinkley et al. (2011)

Keck Masking Limits
Debris Disk
Known planets
Marois et al. (2010)
HD32297 with Project 1640 at Palomar

- P1640 scattered light YJH imaging.
- Spatially resolved morphology/spectrum

→ Goals:
  - Density profile,
  - Grain size distribution

Lebreton, Pueyo, Beichman et al. (in prep)
Conclusions

• Keck/VLT observations of 262 Stars with 22 μm excess.

• The majority of targets have no previous high-contrast observations.

• Following 100 candidate companions.

• Sparse Aperture Masking will open the inner regions of young systems e.g. β Pic.