The Transitional Disks Associated With Herbig Stars

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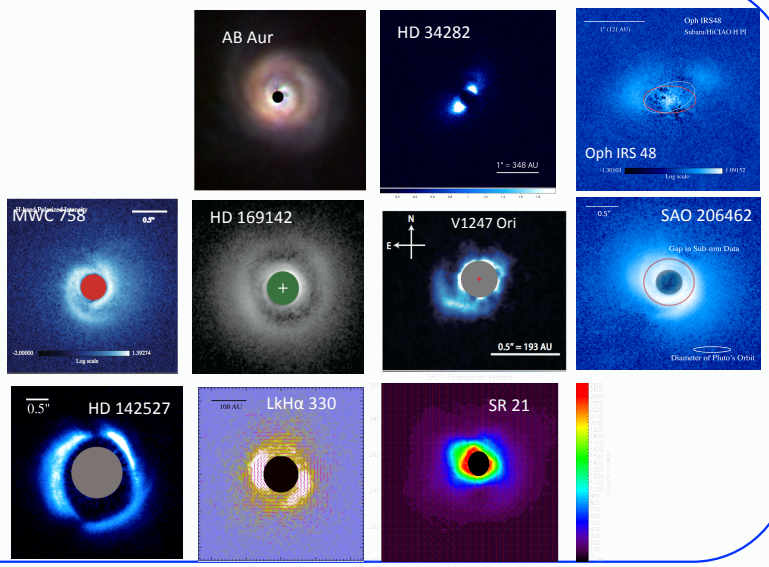
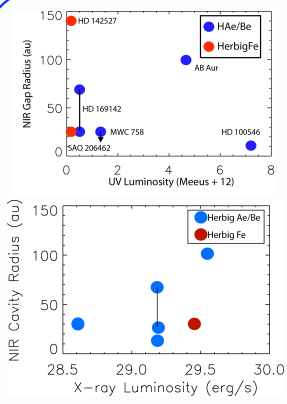
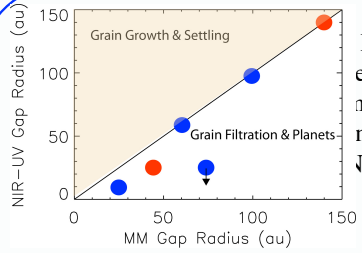
Abstract: As part of the *Strategic Exploration of Exoplanets and Disks with Subaru* YSO survey, we have surveyed a number of Herbig B-F stars mainly at H-band using Polarimetric Differential Imaging+Angular differential imaging. Historically, Herbig stars have been sorted by the shape of the IR SEDs into those which can be fit by power laws over 1-200 μm (Meeus et al. 2001, group II), and those which can be interpreted as a power law + a blackbody component (Meeus group I) or as transitional or pre-transitional disks (Maaskant et al. 2013). Meeus group II disks, when imaged with HiCIAO show featureless disks with depolarization along the projection of the disk semi-minor axis (Kusakabe et al. 2012). This is what we had expected to see for the Meeus group I disks, except for the addition of wide gaps or central cavities. Instead we find wild diversity, suggesting that transitional disks are highly perturbed compared to Meeus group II disks. To date, similar structure continues to be observed as higher Strehl ratio imagery becomes available.

- Including the disks shown here, and other systems still being analyzed, >92% of stars detected in scattered light, >> than for Meeus group II disks(~25%) or debris disks (10%).
- NIR gaps and cavities in >40% of objects NIR gap is <36% - 100% of sub-mm cavity size, and eccentric in several cases.
- spiral arms in > 6 stars, partial circular arcs in 2 stars.
- spiral arms part of disk in case of AB Aur (Lomax et al. 2015).
- double gap in HD 169142 – outer gap is density deficit not shadow (Wagner + 2015)
- Modeling of images + SEDs indicates that both loosely wound arms and disk are consistent with h/r~0.2 (Swearingen et al. 2015, in prep.).





- Disk clearing via photo-evaporation should produce a correlation between cavity size and UV Luminosity – not seen for Herbig stars with data in Meeus + (2012).
- No correlation between NIR gap radius and Lx seen.
- Photoevaporation can't produce multiple gaps in a single disk, particularly at tens of au from the star.



Dust grain growth and ettling should produce illimeter disks which are maller than the NIR gaps. – lot seen for Herbig stars.

- MM gap radius ≥ NIR is expected as a consequence of grain filtration associated with dust traps. Gas cavity size should Correlate with NIR gap size.
- Dust trap models require an giant planet interior to the millimeter gap. Candidates are known for 2 Herbig star systems.

References for Individual stars: AB Aur – Hashimoto et al. 2010 HD 34282 – Maruta et al. 2015 (in prep.), Oph IRS 48 – Follette et al. 2015, MWC 758 – Grady et al. 2013, HD 169142- Momose et al. 2015, V1247 Ori – Ohta et al. 2015, SAO 206462- Muto et al. 2012, HD 142527 Fukagawa et al. (in prep), LkHα 330- Bonnefoy et al. (in prep), SR 21 – Follette et al. 2014

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