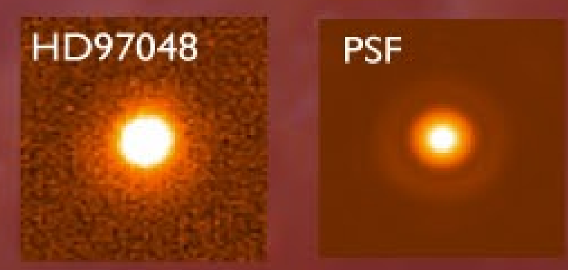
Are all flaring Herbig disks transitional?

Introduction

Young protoplanetary disks evolve towards planetary systems in several million years. During that time, the formation of massive planets is thought to correspond to large gaps in the disks. In this study we characterize the sizes of gaps. We have focussed on a special group of disks around intermediate mass (Herbig Ae/Be) stars: HD97048, HD169142, HD135344B and Oph IRS 48. These objects do not show prominent silicate emission features although they still bear signs of flaring disks.

Methods and data

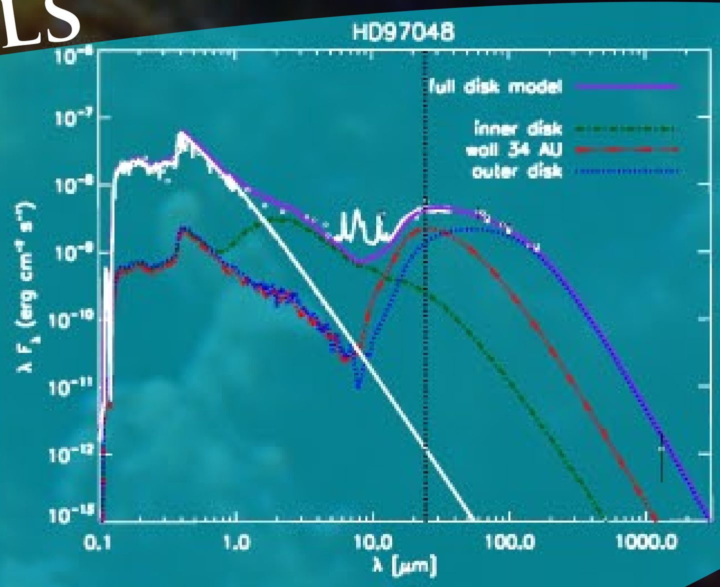
We investigate Q- and N-band MIR images taken with Subaru/*COMICS*, Gemini South/*T-ReCS* and VLT/*VISIR*. See below for an example of a resolved Q-band observation of *HD97048*. We perform radiative transfer modeling using the code 'MCMax' to examine the geometry of the disk. The radial distribution of dust and PAHs are fitted to the SEDs and N- and Q-band images.



24.5 micron *T-ReCS*

Radiative transfer models

Object	M_{dust} [$M_\odot$]	M_{halo} [$M_\odot$]	$R_{innerdisk/halo}$ [AU]	R_{wall} [AU]	R_{out} [AU]	a [a_{min}, a_{max}]	p
HD 97048	6.0×10^{-4}	...	0.3–2.5	34^{+4}_{-4}	500	{0.5 μm, 1mm}	−3.5
HD 169142	0.8×10^{-4}	0.31×10^{-12}	0.1–0.2	23^{+4}_{-4}	235	{0.5 μm, 1mm}	−3.5
HD 135344 B	1.0×10^{-4}	0.47×10^{-12}	0.1–0.3	30^{+4}_{-3}	200	{1.0 μm, 1mm}	−4.0
Oph IRS 48	3.0×10^{-5}	0.50×10^{-12}	0.1–0.3	63^{+4}_{-4}	235	{0.1 μm, 1mm}	−4.0

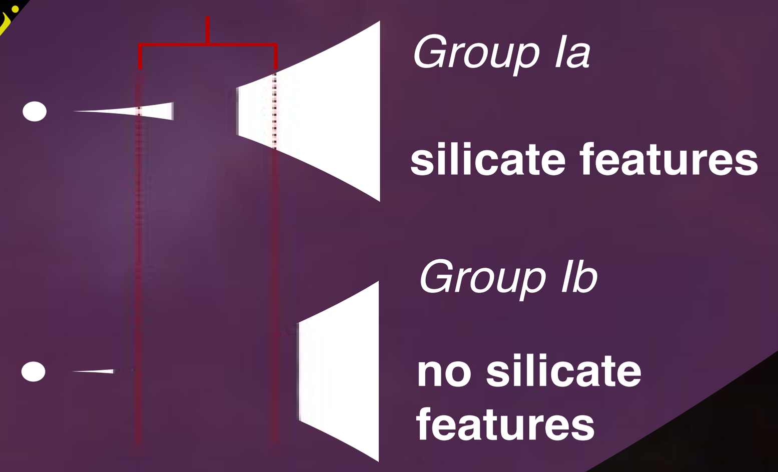


General results:

All four disks (*HD97048*, *HD169142*, *HD135344B* and *Oph IRS 48)* are characterized by large gaps separating the inner and outer disk. Emission in the Q-band is dominated by the inner edge of the outer disk. By fitting the SED and Q-band images, we derive radii of the inner edge of the outer disks of 34, 23, 30 and 63 AU respectively (see table above for model properties). For *HD97048* this is the first detection of a disk gap (34 AU). The figure on the right shows the decomposed SED model of *HD97048*. Modeling of the N-band (including PAHs and VSGs) is done separately. See N-band results bottom right of this poster.

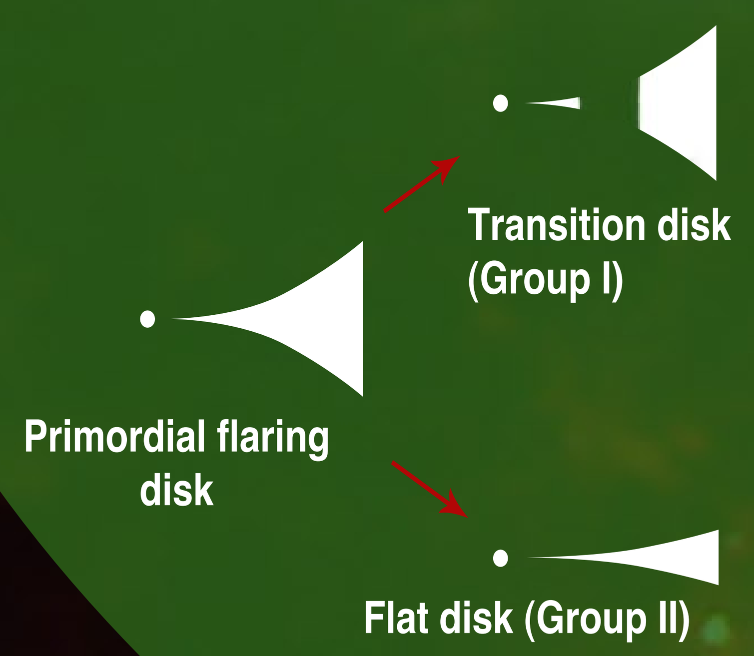
Conclusion 2: Weakness of silicate features caused by gaps

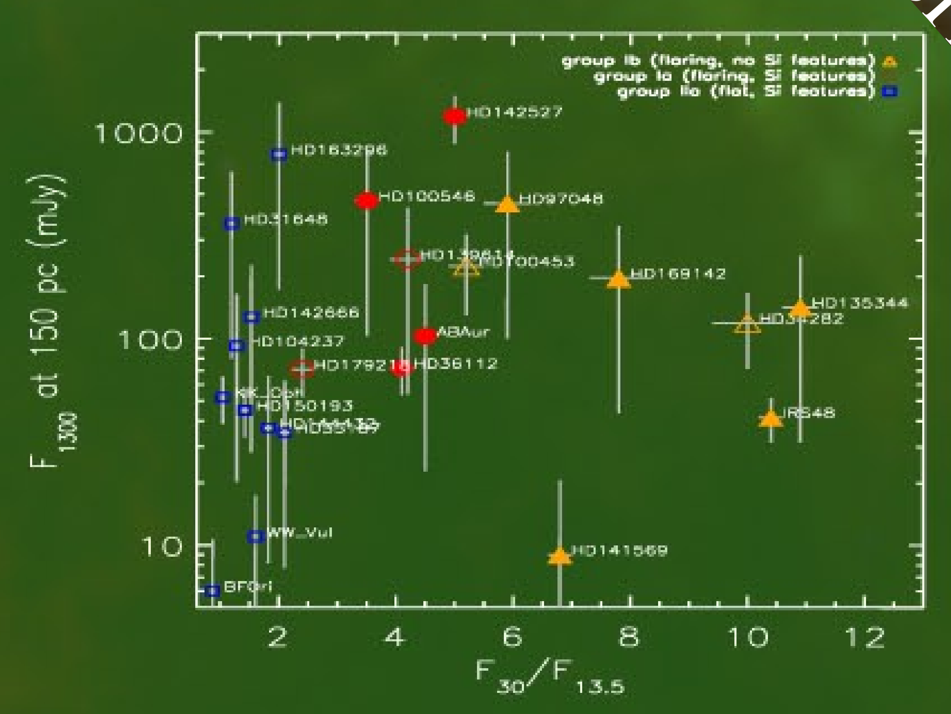
As indicated by the sketch below, the absence of silicate emission features can be explained by large gaps in the critical temperature regime in which silicate features are produced.



Conclusion 1: Are all flaring group I disks transitional?

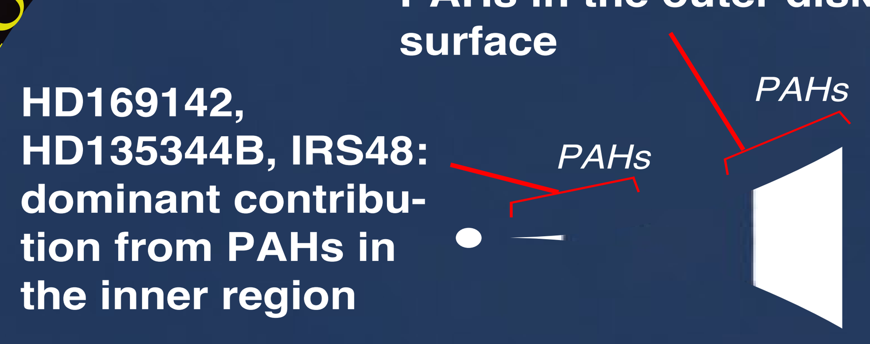
Many, if not all flaring Herbig disks with Spectral Energy Distribution (SED) classification 'group I' have large gaps and thus are (pre-) transitional. An evolutionary path from the observed group I to the observed group II (flat disks) sources seems no longer likely. Instead, both might derive from a common ancestor as shown by the sketch on the left.



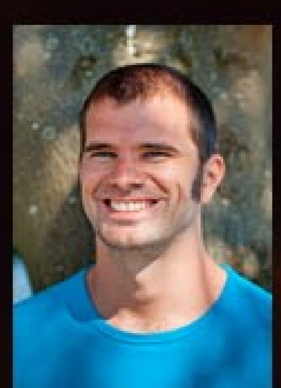


The right Figure shows the flux ratio at 30.0 and 13.5 μm for all Herbig stars with available sub-mm flux at 1.3 mm (normalized at a distance of 150 pc). The absence of silicate features (orange triangles) and the presence of gaps (filled symbols) correlate with the MIR color. Therefore, the MIR spectral slope may trace dust gaps in the temperature range T ~ 200-400 K

Conclusion 3: PAH emission not always from the outer disk



Modeling of the N-band VISIR data indicates that the PAH features do not always orignate in PAHs from the outer disk.



Koen M. Maaskant
Leiden Observatory
Mail: maaskant@strw.leidenuniv.nl

Maaskant et al 2013,
collaborators: M. Honda, L.B.F.M. Waters, A.G.G.M. Tielens, C. Dominik, M. Min, A. Verhoeff, G. Meeus, and M. E. van den Ancker