Gas and Dust in Debris Disks

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SMA: First Decade of Diskovery

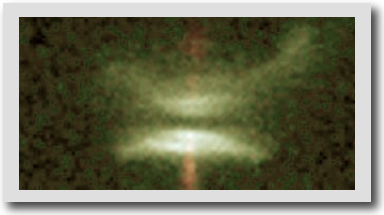
Circumstellar Disk Evolution

PROTOPLANETARY

Pre-MS stars

Gas-rich

Primordial dust



HH 30, Burrows et al. 1996

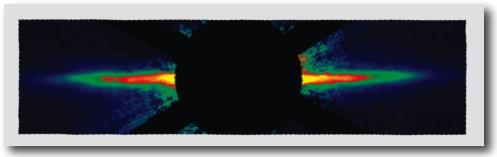
planets?

DEBRIS

Main sequence

No (or very little) gas

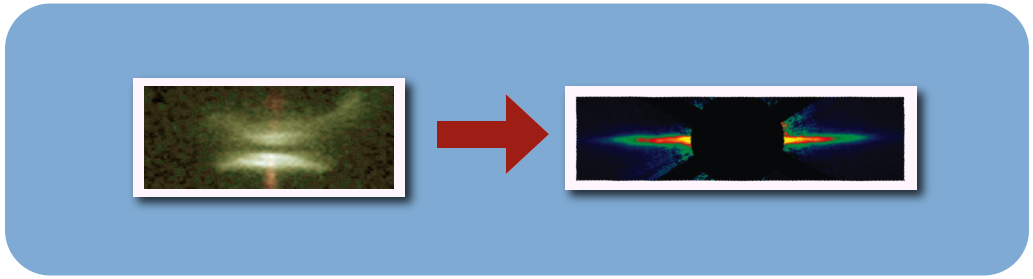
Dust must be replenished



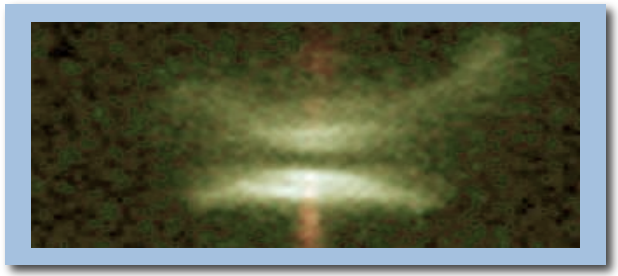
AU Mic, Liu et al. 2004

Some Questions:
When and why do disks disperse?
How normal is our solar system?
What can disks tell us about planet properties?

1. Disk Dissipation

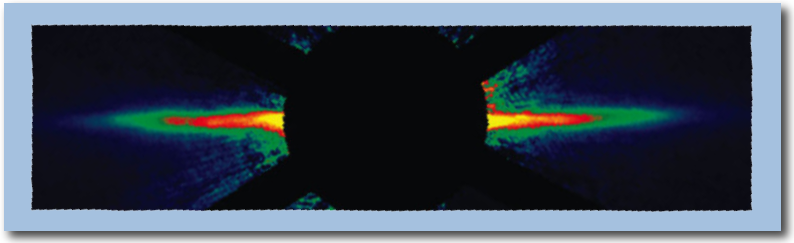


The standard story



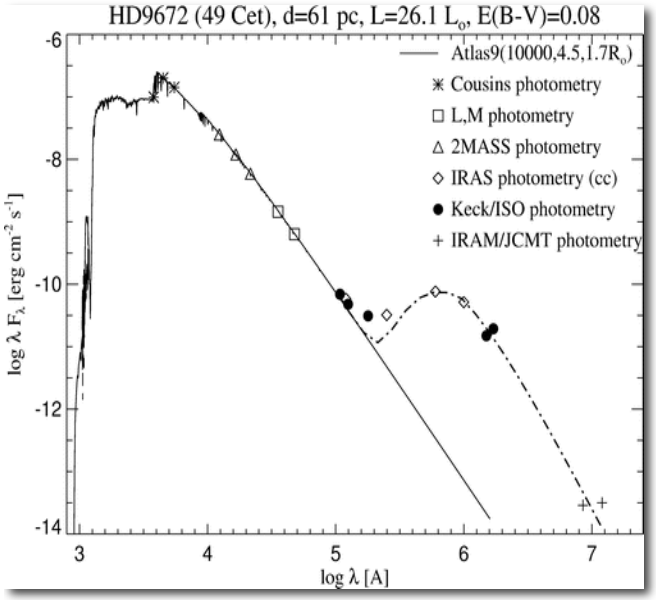
Lots of gas/dust left over from SF

Gas/dust disappear (~10Myr)

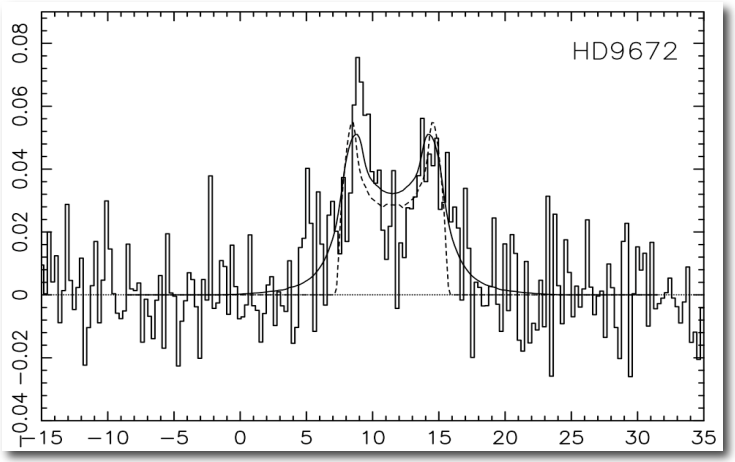


Debris dust only

Then what is this?

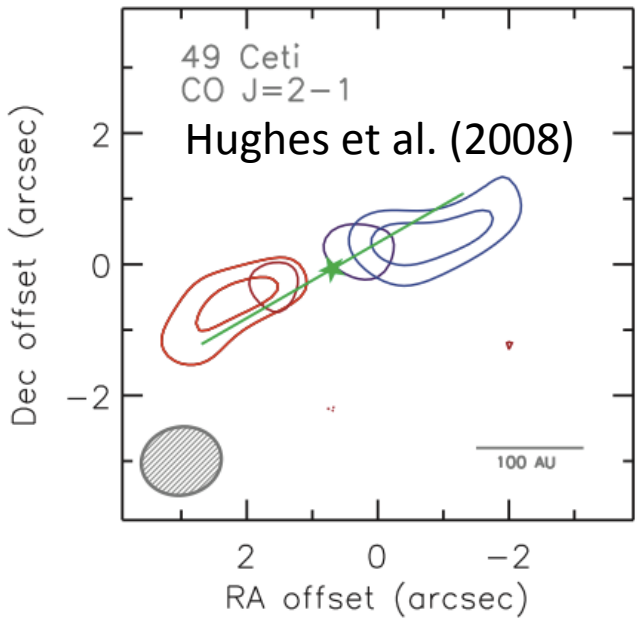


Dust looks like a debris disk…



But still has lots of molecular gas!

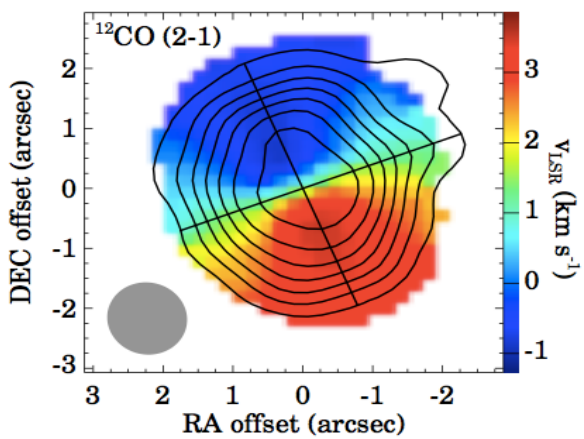
49 Cet and HD 21997

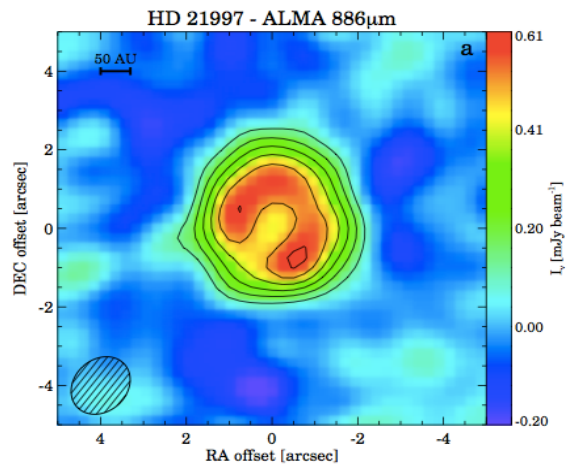


Gas disk with inner cavity of ~90 AU
Consistent with photoevaporation

BUT… age pushed back to 40 Myr!!!
Must be comets(?).

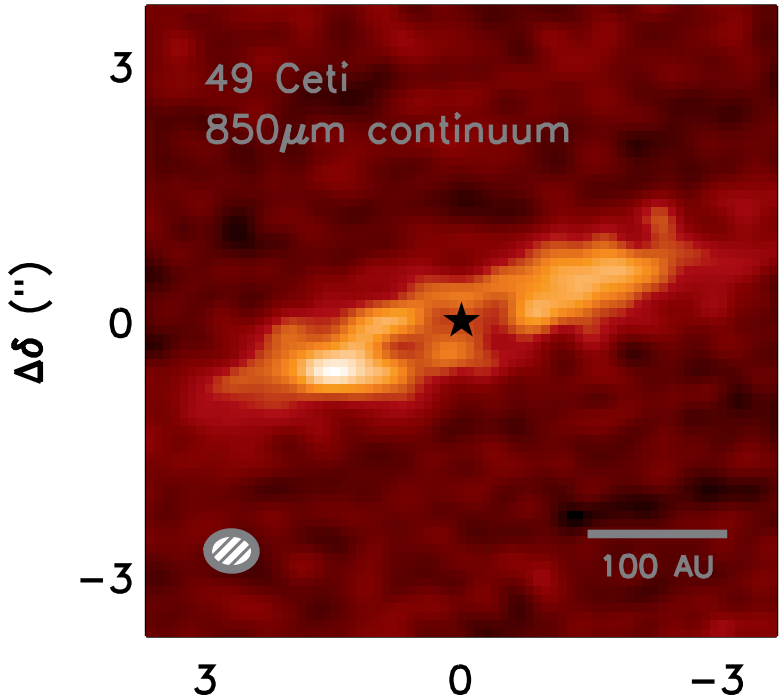
CO lifetime of 6,000-30,000 years
6000 Hale-Bopp-size comets/year

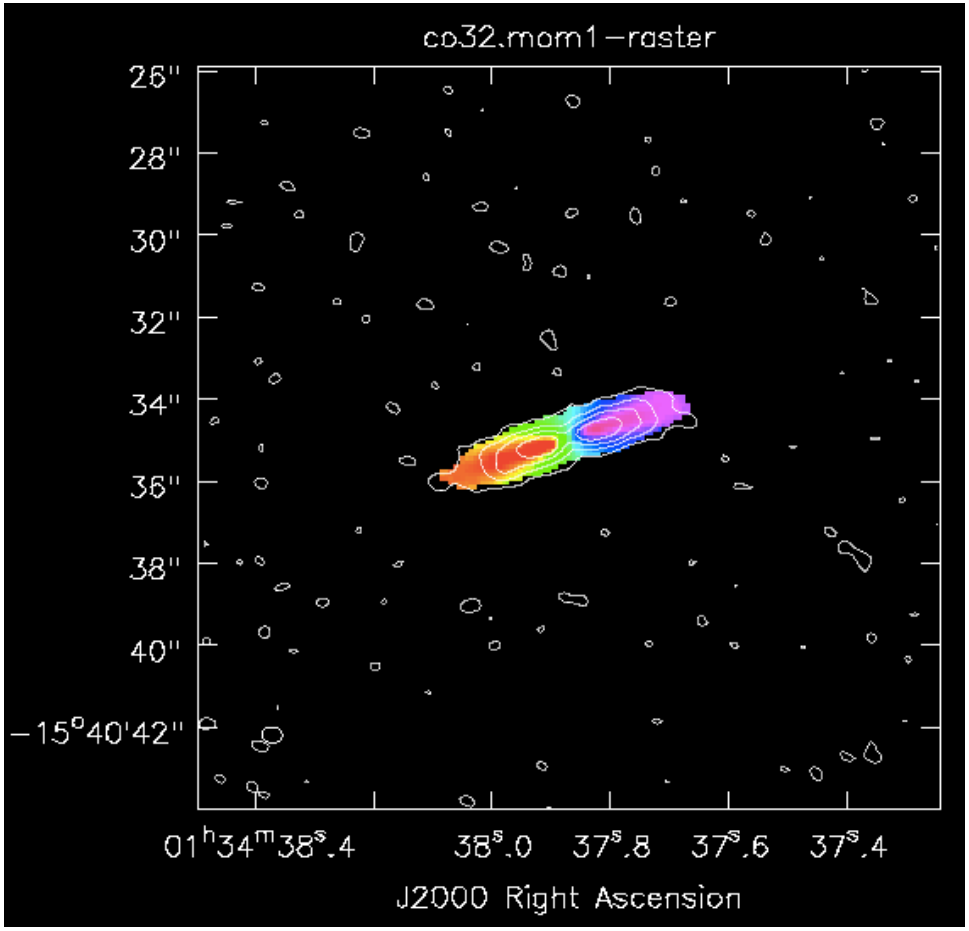




Kospal et al. (2013), Moor et al. (2013)

Ongoing: 49 Cet with ALMA



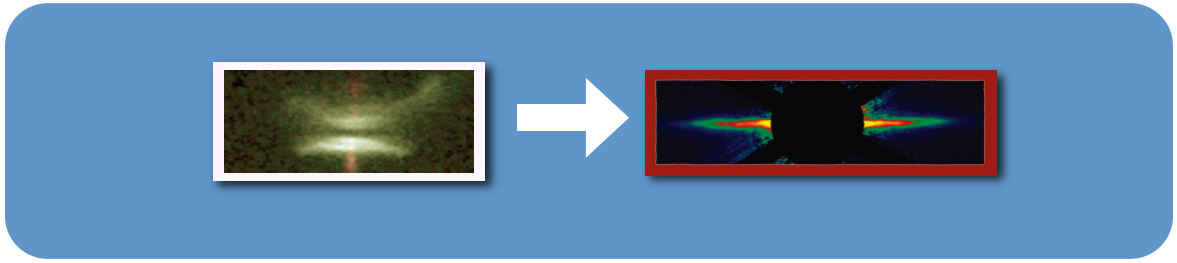


How: Imaging of gas and dust

Is the gas primordial (Peter Pan disks) or second-generation (evaporating comets)?

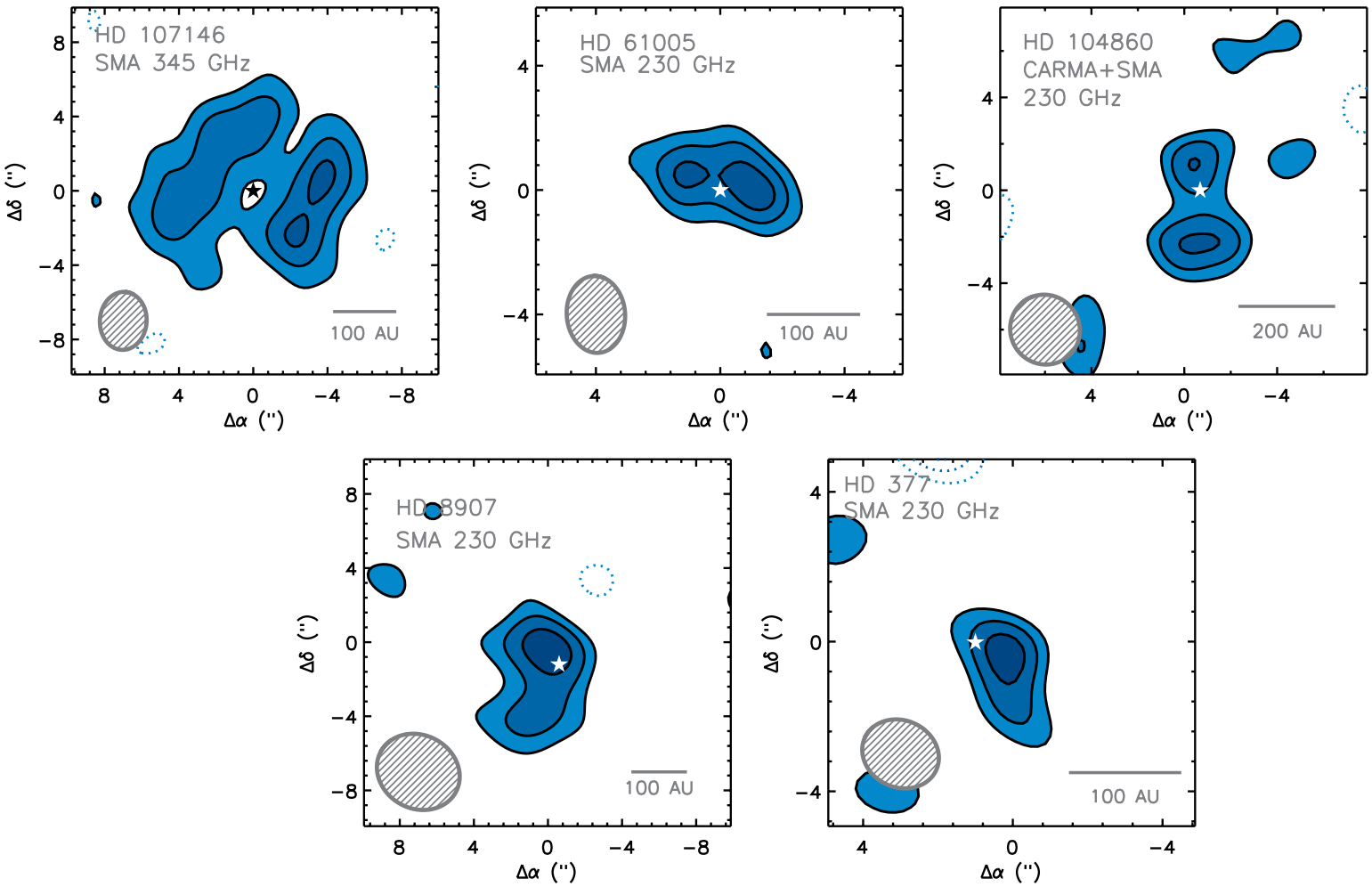
- Gas/Dust morphology: Are they in the same place?
- Gas mass/lifetime: How does it compare to age of star?
- Gas chemistry: Is it more similar to a disk or a comet?
- Frequency: Are we seeing something common or unusual?

2. Resolving Debris Disk Structure



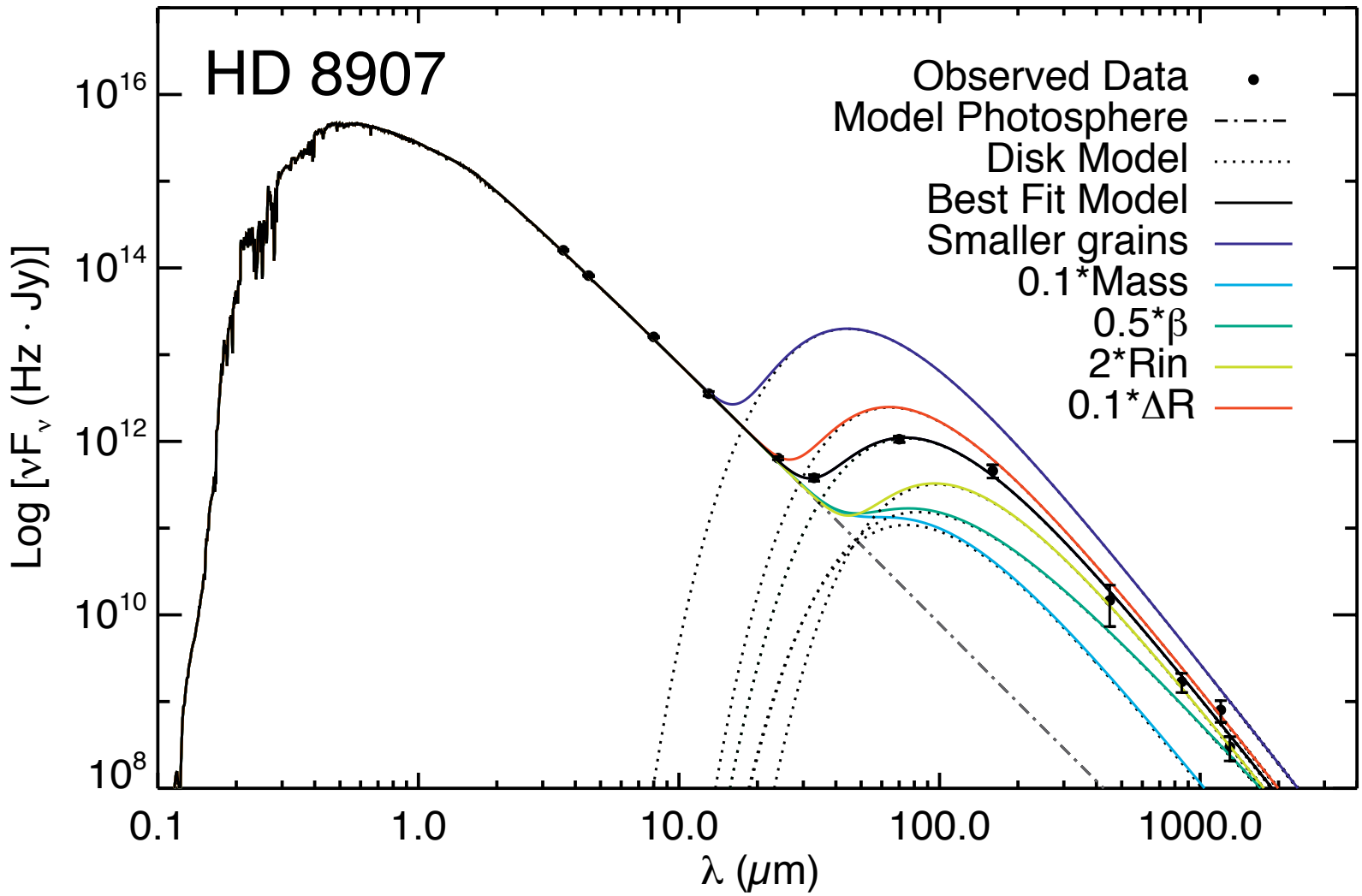
Our Solar System ~4.4Gyr ago?

Uniform sample of debris disks spatially resolved using mm-wave interferometry
Sample: young Solar analogues from FEPS



Steele et al. in prep

Model Parameters



Results

Parameter	HD 377	HD 8907	HD 61005	HD 104860	HD 107146
R_{in} (AU)	40	50	60	120	60
ΔR (AU)	<70	<10	<10	<13	109
α (μm)	28	1.9	1.2	1.6	1.6
β	0.9	1.1	0.4	0.5	0.7
M_D ($M_\oplus$)	0.0063	0.0039	0.0063	0.0019	0.0032
Axisymmetric?	Y	Y	Y	Y	Y

Conclusions

- Most radii are similar to the Kuiper belt
- Grain sizes are comparable to the blowout grain size →1-3x larger than the BB radius
- Only one disk has a resolved width
- No detected asymmetries