



Modelling results Grant Kennedy, Cambridge, UK

Why model disks?

- Resolved disk examples
 - + get grain sizes
 - * see structure & infer history
- Two-temperature disks
 - infer structure (i.e. two belts?)
 - * origin of warm components?

Resolved disks



Kennedy+2012b

Disk spectra

Size distribution means D_{min} and r_{disk} degenerate



Resolved disks: measure rdisk, get Dmin

Kennedy&Wyatt14



Booth+2012

Procedure



 Create disk model: get r
 Make disk spectrum at r (with size distribution)
 Find D_{min} to get a match [™]

also get geometry (+ other info if resolution is good)



Disk size \geq BB size ($\Gamma = R_{disk}/R_{BB} > 1$)



Grain size and stellar mass

more stirring in disks around higher mass stars? (but grain properties could be different too) linked to higher planet frequency?



Pawellek+2014, Thebault+08



Doolin+13

i relative to binary orbital plane Ω relative to binary pericenter

Circumbinary dynamics

coplanar

. × pericenter

e=0.77



Circumbinary dynamics



Tracer of star formation

"close & tidy"

"wide & messy"



β Tri α CrB HD98800BaBb 99 Her DE Boo

NRAO, Hale et al 1994, Reipurth et al 2014

Binary-disk alignment



Moerchen+2010, Kennedy+2012b

ð offset (")

Primordially aligned? Yes



99 Herculis



Disk perpendicular to pericenter direction? P=50 years, t_{sec} ~0.5Myr @ 120au (i.e. particles must be perturbed)



Kennedy et al 2012a



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99 Herculis:single particle,2 parametermodel







Resolved disks - summary

- Dozens of disks now resolved
 - Grain sizes larger than expected for Sun-like
 - No signs of "tilted" disks (yet)
 - Close binary disks aligned (4), wide are not (1)
- Much more detailed modelling to be done
 - * e.g. reconciling HST with Herschel

Two-temperature disks



Chen+07, Morales+11, Su+09, Ballering+14

HR8799 - planets between belts (sound familiar?)



Talks by Hinkley, Booth to come. Poster by Zakhozhay

Matthews+14, Marois+10





Duchene+14

η Corvi

- The other "original" twotemperature disk
- Inner belt mid-IR confirmed
- No material seen between inner and outer belts
- Different minimum grain sizes, smaller in warm belt
- Possible origin in outer belt
 (FEBs?)

Ratio of temperatures constant - surprising? do all therefore have the same origin? T_{warm}/T_{cool} 10 RT two-temperatures not detectable 5000 6000 7000 8000 9000 10000 T_{eff} Kennedye3Wyatt14

Two-temperature diagnostics



Kennedye3Wyatt14



Kennedye3Wyatt14, Donaldson+13, Lebreton+12

Blowout size varies & ≠ blackbody!



HD 207129

Parent bodies ≠ disk!



Löhne+12, Reidemeister+11, van Lieshout+14



Two-temps - summary





transport important Kuiper/Asteroid belt analogues (PB unrelated)

Comet delivery (link w. FEBs?)

 $\frac{r_{\rm out}}{r_{\rm in}} \approx 10$

a future goal: correct interpretation without images (an application: planet hunting)







- Resolved disks:
 - Uniform studies revealing stellar mass trends
 - No signs (yet) of star-disk misalignment
 - * Goals: stellar mass dep. and dynamical history
- Two temperature disks:
 - Potentially powerful but understanding needed
 - Goal: predict system structure from SED

Two-temps - summary?

