

# The structure of Herbig-star disks as seen with MIDI

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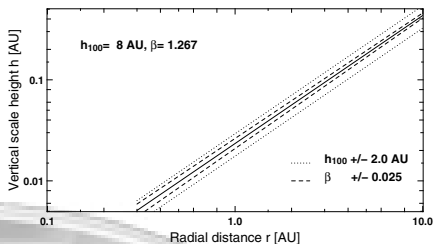
**R. van Boekel, Th. Henning**

Max Planck Institute for Astronomy, Heidelberg [D]

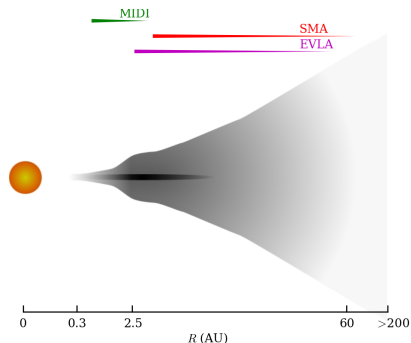


# Intro: protoplanetary disks & MIDI

## Disk structure



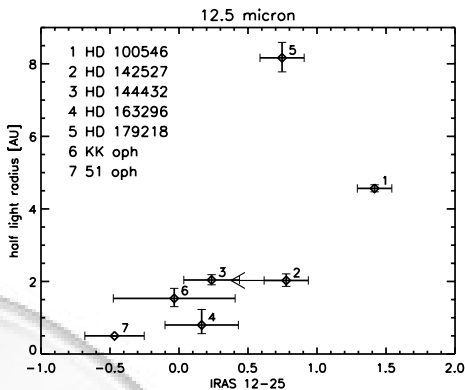
Flaring disk of AB Aur  
(di Folco+ 2009)



Rounded rim of TW Hya  
(Menu+ 2014)

# Intro: protoplanetary disks & MIDI

## Disk populations



Sizes of “flaring” and “flat” disks (Leinert+ 2004)

## Disk structure & MIDI



- well-defined disk structure for several targets
- hints of different disk populations



## Disk structure & MIDI



- well-defined disk structure for several targets
- hints of different disk populations



- lack of statistics: case studies difficult to combine/compare
- archive with lots of data, many objects untouched

# The MIDI-Herbig project

« *Collective data reduction and analysis of (almost) all MIDI data of intermediate-mass young stars* »

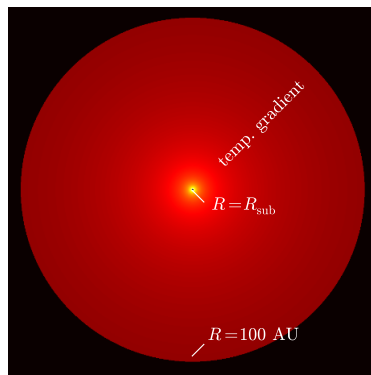
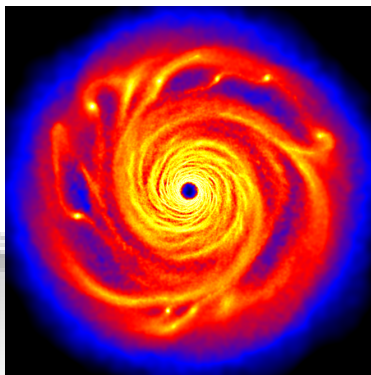
**Data:** 239 nights of archival MIDI observations, 80 targets

## **First results:**

- 1 size-luminosity relation
- 2 towards a family picture

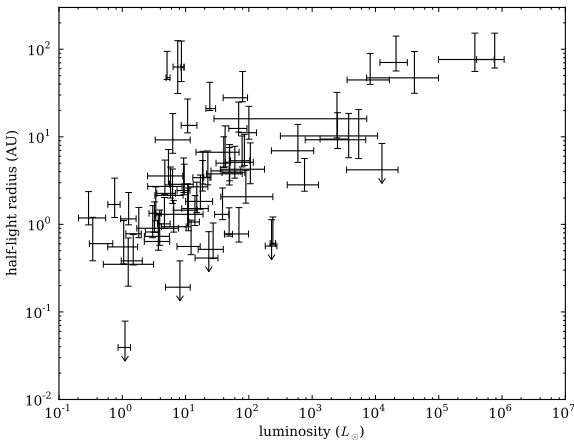
# First results: 1. Size-luminosity relation

**Principle:** complex disk  $\rightarrow$  simple disk



**Fig left:** Rice+ (2003); *right:* temperature-gradient disk

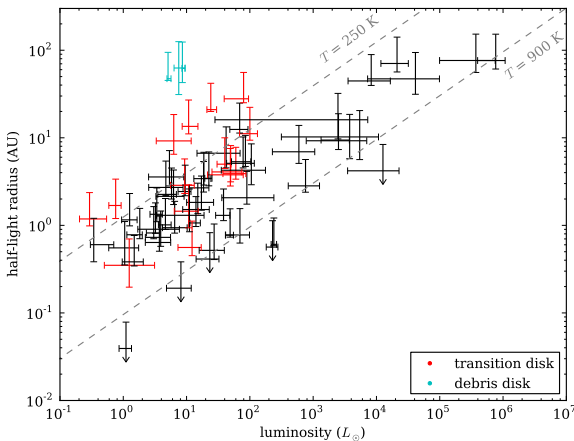
# First results: 1. Size-luminosity relation



**Fig** Mid-infrared ( $10\text{-}\mu\text{m}$ ) size-luminosity relation

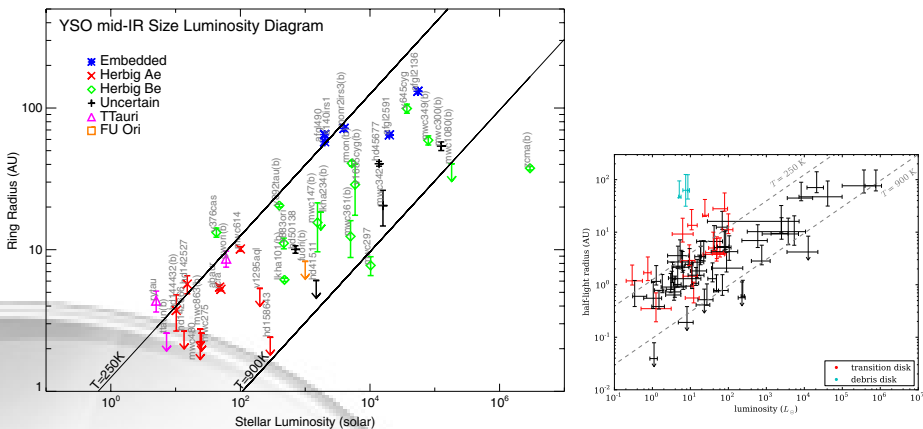


# First results: 1. Size-luminosity relation



**Fig** Mid-infrared (10- $\mu\text{m}$ ) size-luminosity relation

# Comparison with Monnier+ (2009)



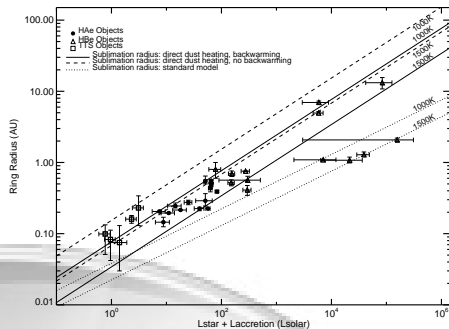
**Fig** Mid-infrared size-luminosity relation: Monnier+ (2009) vs. MIDI

Near-IR

vs.

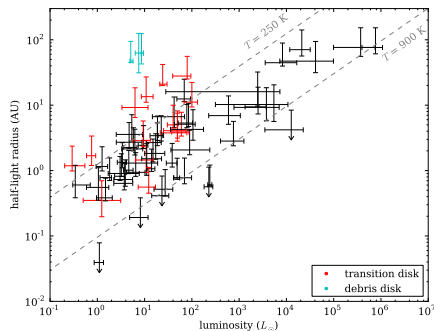
Mid-IR

Millan-Gabet+ (2007)

*tight* relation

Physics: dust sublimation

Our MIDI sample

*loose* relationPhysics: **flaring + gaps?**

# Flaring

Flaring disk intercepts more stellar flux

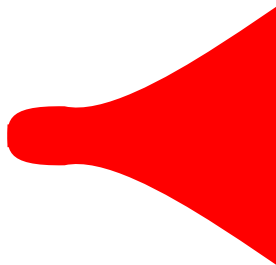
Mechanism:

$\#(\text{small grains}) \uparrow \implies \text{flaring} \uparrow$

Observational appearance of disk:

- 1 larger
- 2 redder

$\Rightarrow$  small, large



**Fig** Strong vs. weak flaring







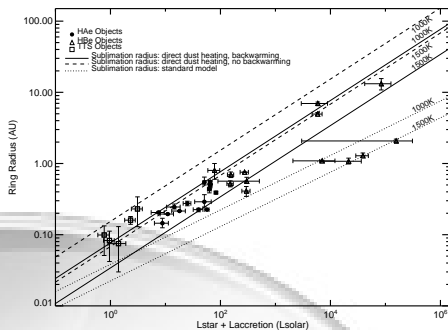
Near-IR

vs.

Mid-IR

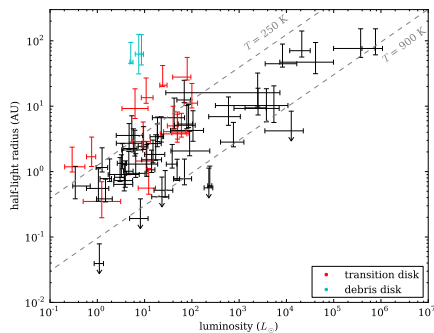
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Millan-Gabet+ (2007)

*tight* relation

Physics: dust sublimation

Our MIDI sample

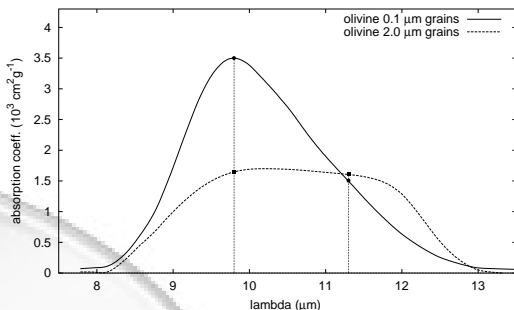
*loose* relationPhysics: **flaring + gaps**



## Flaring: correlation with spectra?

**Physics of flaring:**  $\#(\text{small grains}) \uparrow \implies \text{flaring} \uparrow$

**Expected:** correlation between disk size and spectra  
(= probe for small grains)



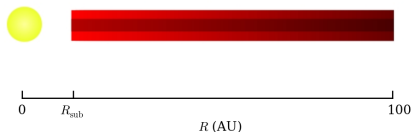
**Fig** Emission of sub-micron and micron-sized silicates (Przygodda+ 2003)





## First results: 2. Towards a family picture

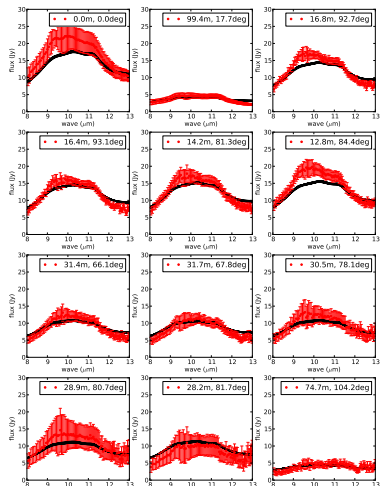
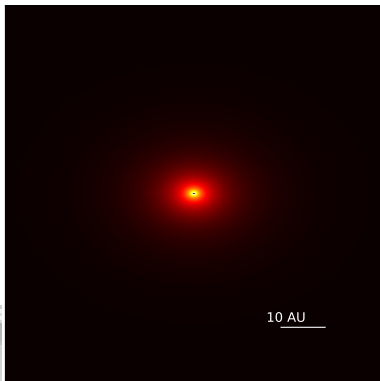
Two-layer model, homogeneous disk



Physics:

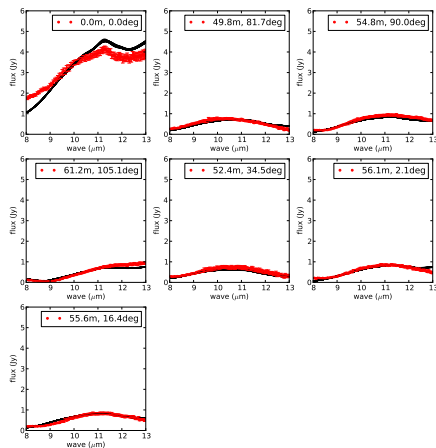
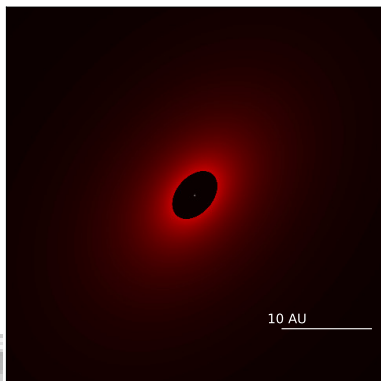
- 1 inclination  $i$ , position angle  $PA$
- 2  $T(R) \propto R^{-q}$ , with  $R_{in} = R_{sub}$  and  $R_{out} = 100$  AU
- 3 silicate dust species + carbonaceous grains:  $\kappa_i$

# HD 163296



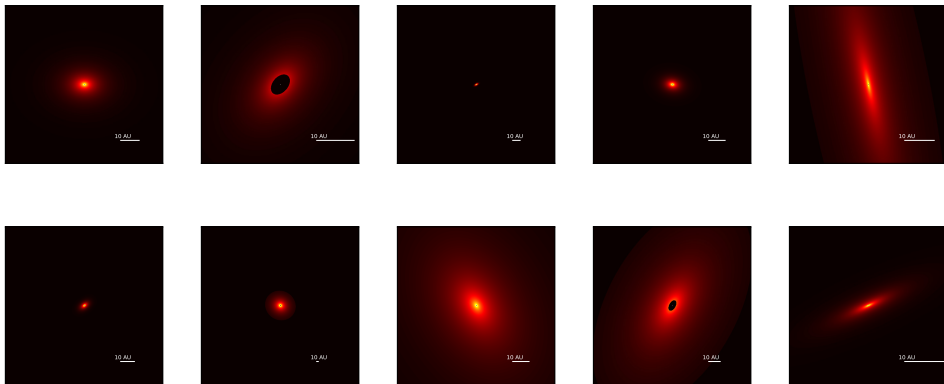
HD 163296: model image (*left*), fit to correlated fluxes (*right*)

## HD 139614



HD 139614: model image (*left*), fit to correlated fluxes (*right*)  
(*cf. Matter+ 2014*)

# A family picture?



**Preliminary “images”:** HD 163296, HD 139614, 51 Oph, HD 104237,  
RY Tau, HD 144668, HD 98922, HD 36112, HD 179218, HD 142560

# Conclusions

MIDI: structure (and composition) of protoplanetary disks

The MIDI-Herbig project: statistics!

Preliminary results:

- 1 size-luminosity diagram for full sample of objects:  
flaring vs. gaps?
- 2 first model images

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