Large inner holes and narrow outer disks from Herschel's observations of transitional disks in Lupus

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Lupus III region - ESO/Digitized Sky Survey 2. Acknowledgement: Davide De Martin
http://www.space.com/19286-dark-space-cloud-stars-photo.html

Introduction to transitional disks

Main characteristics

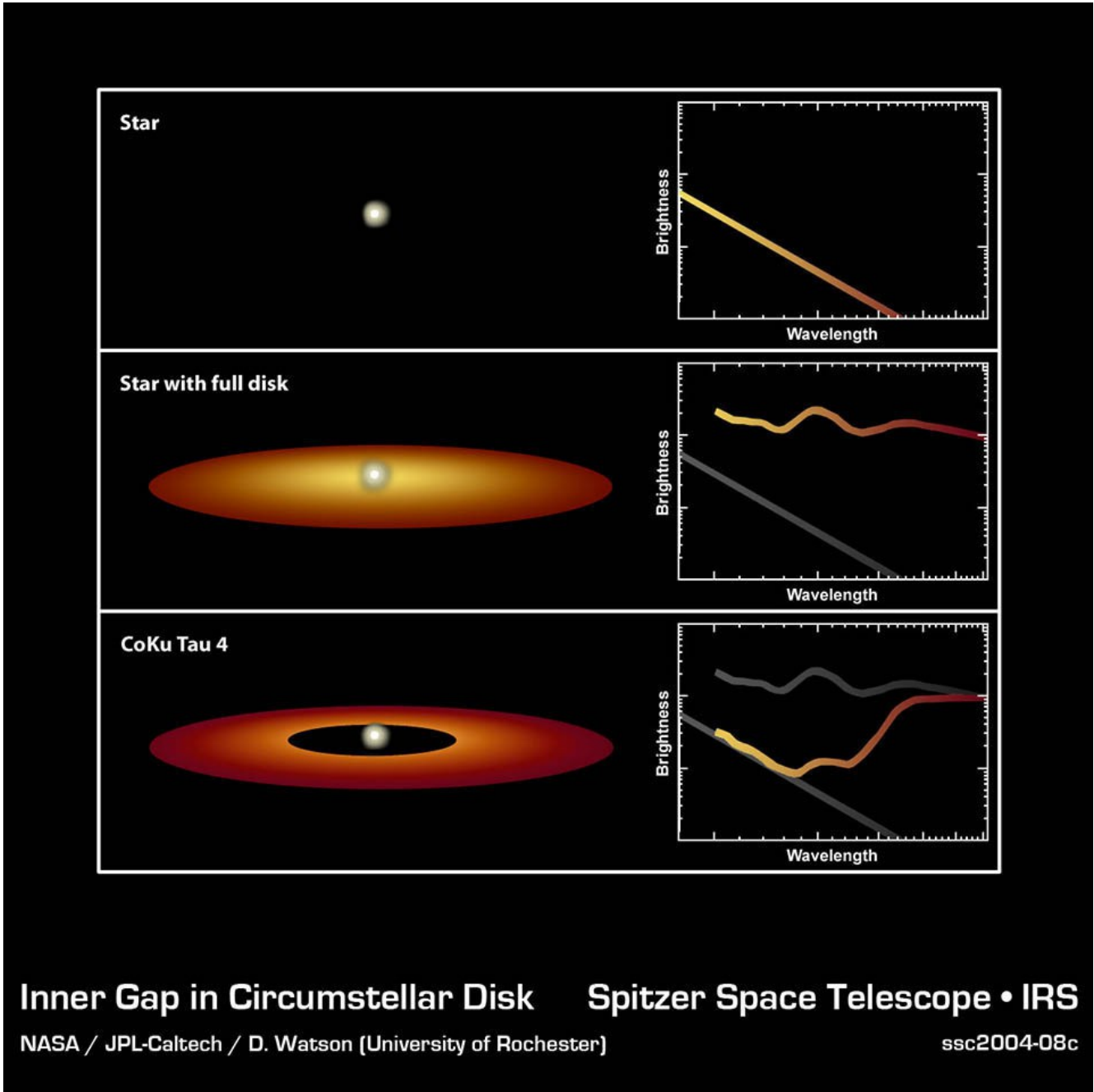
Young stars with disks

Little or no excess at 10μm

Significant one at longer wavelengths

Inner disk clearing - gap

Due to ¿planet formation?



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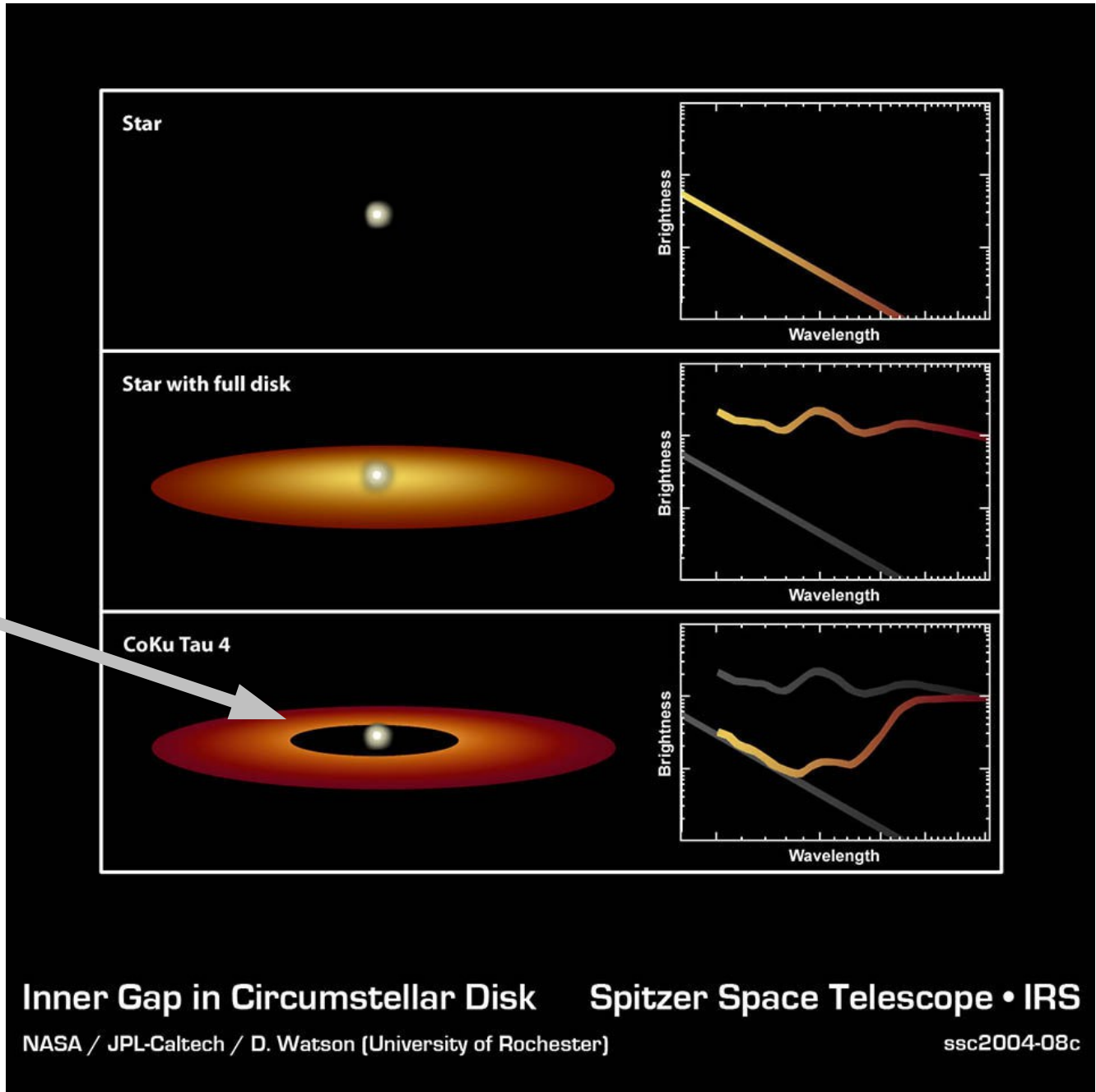

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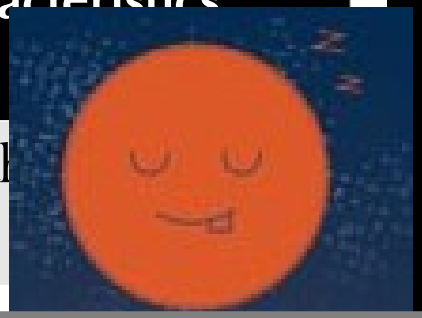
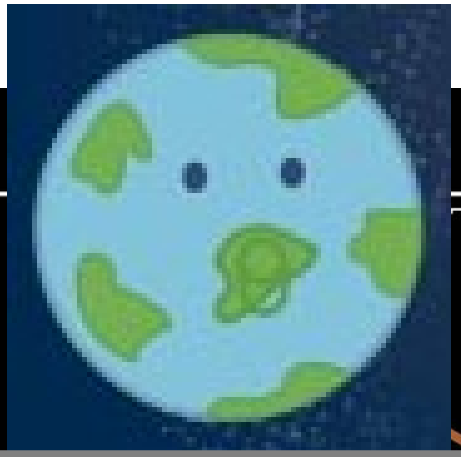




Planet formation??

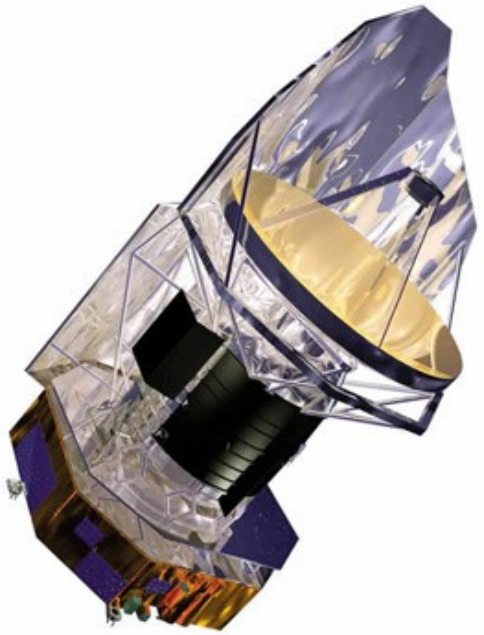
Lupus III - Optical

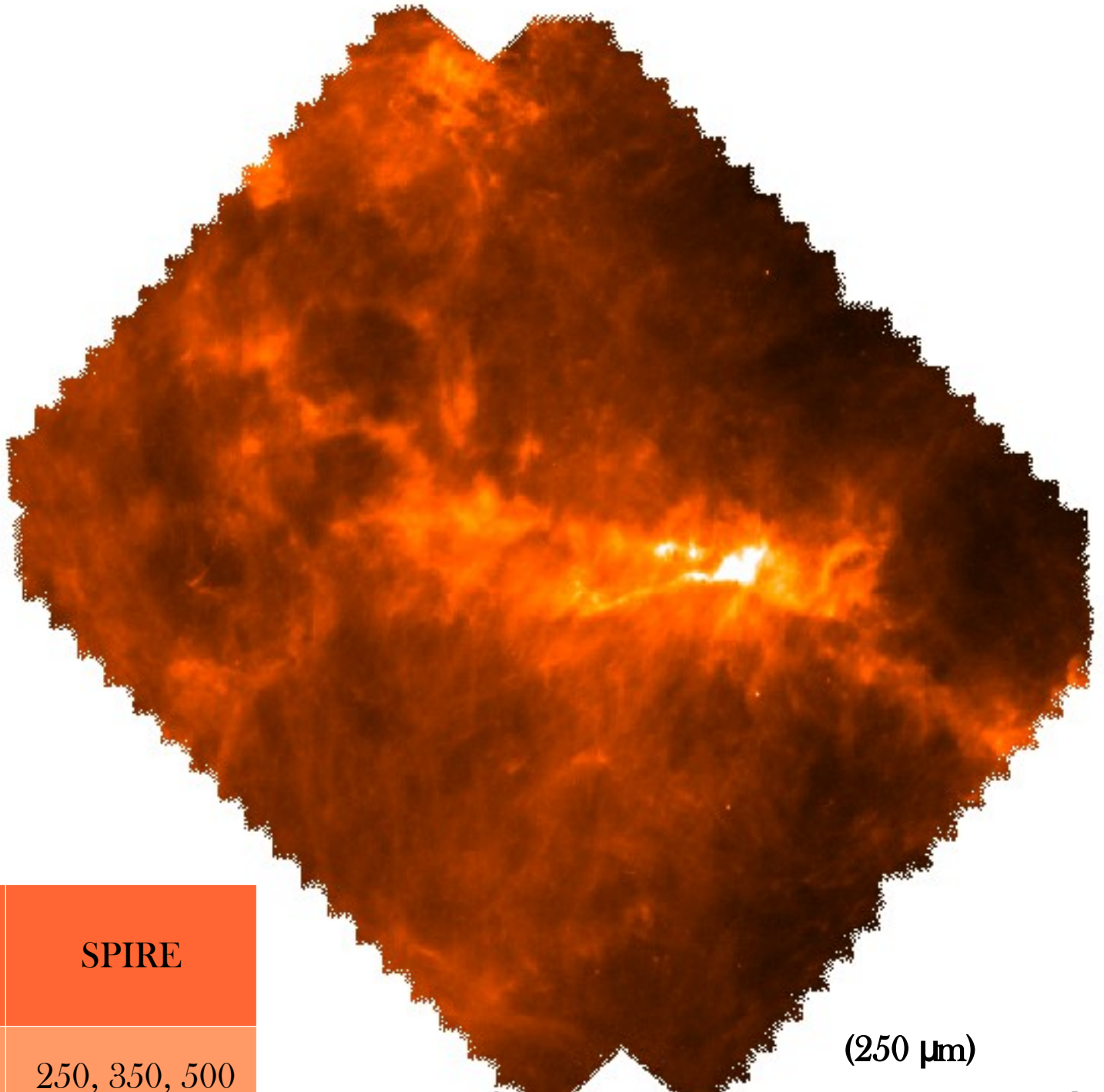
- Nearby region
- Young: 1.5 – 3 Myr
- Star formation

ESO/Digitized Sky Survey 2.
Acknowledgement: Davide De Martin

Herschel data

Lupus III – far IR





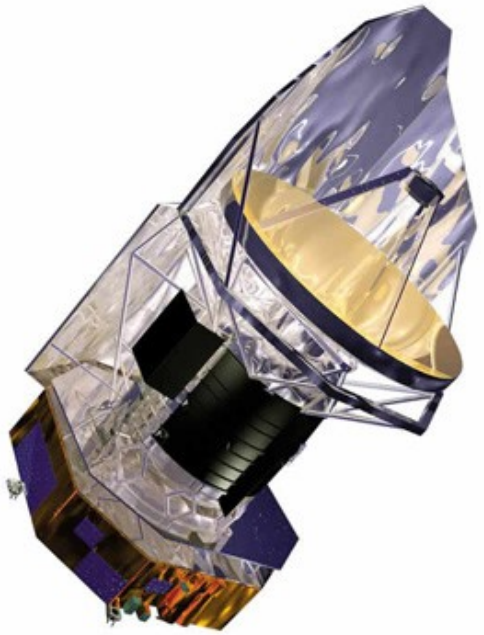
(250 µm)

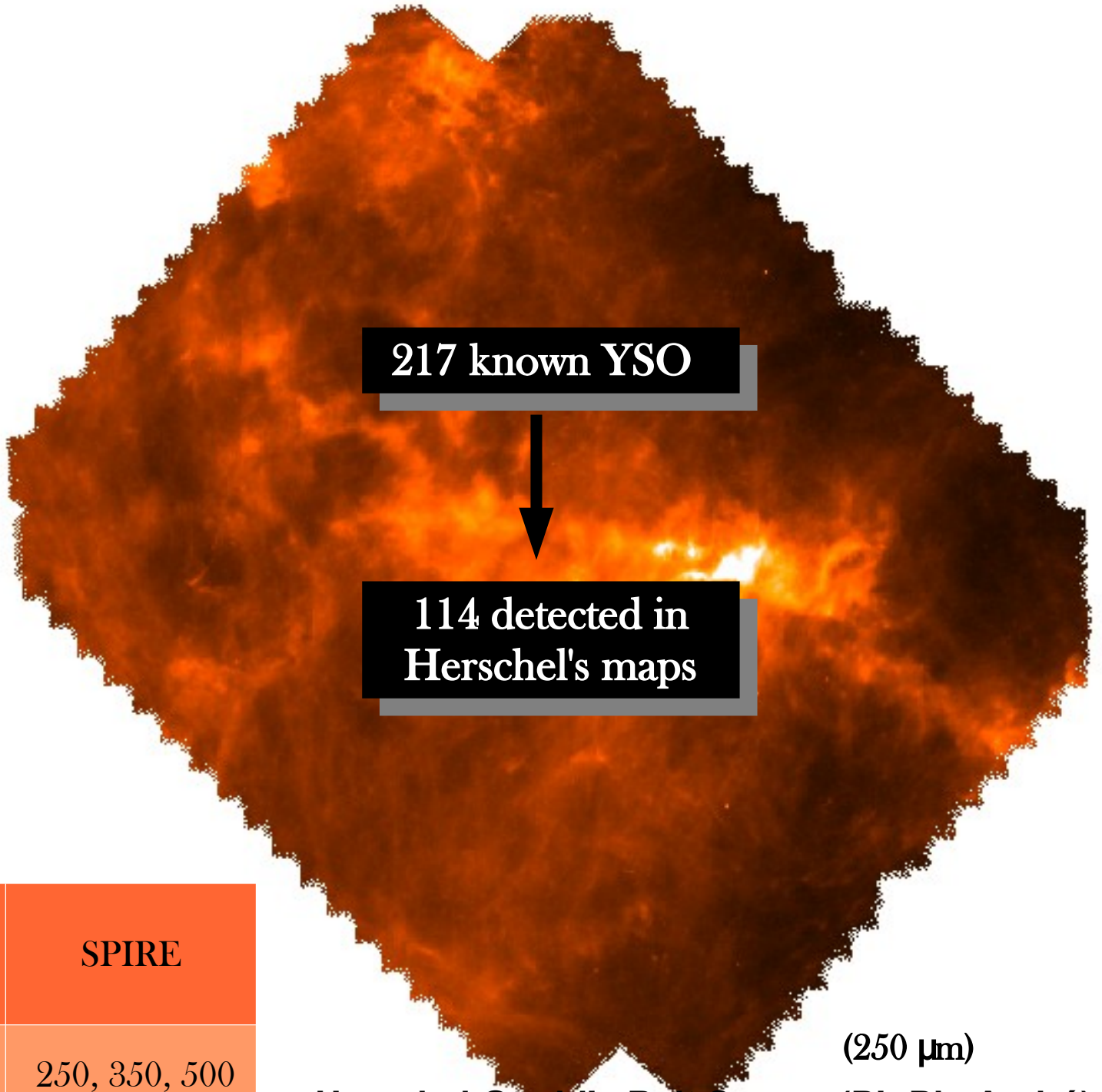
Herschel Gould's Belt Survey (PI: Ph. André)

Herschel imaging instruments	PACS	SPIRE
Wavelengths (µm)	70, 100, 160	250, 350, 500

Herschel data

Lupus III – far IR





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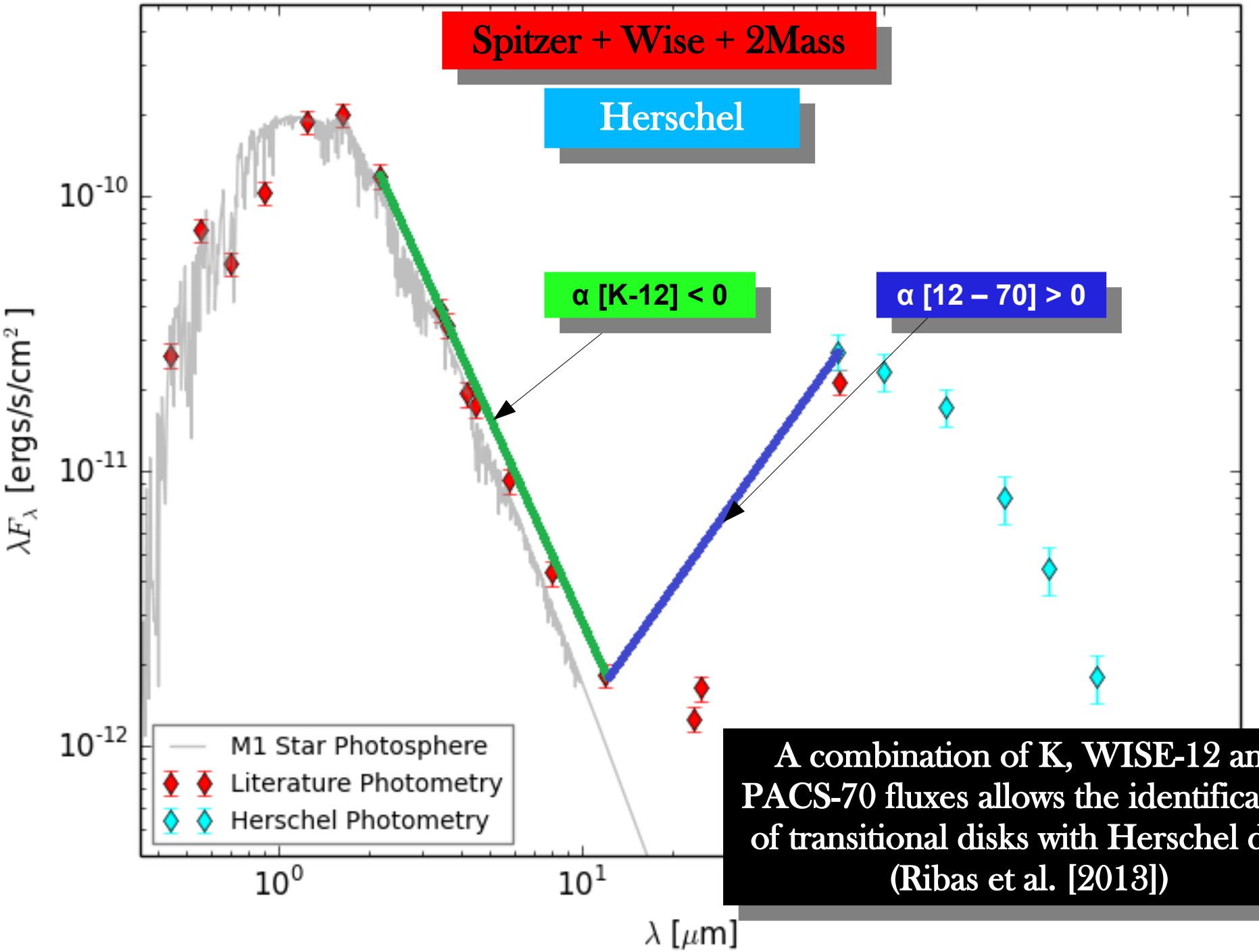
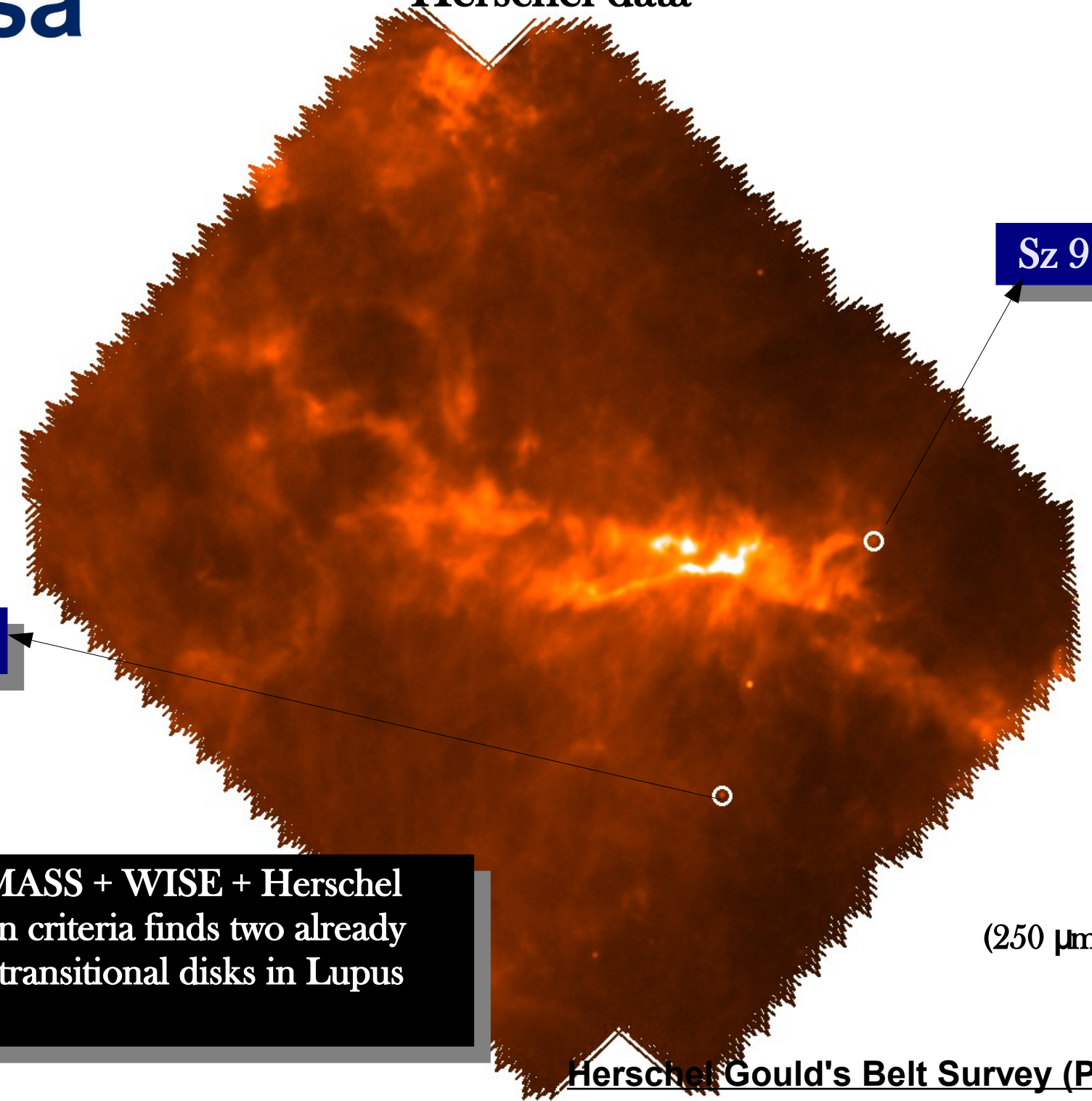


A combination of K, WISE-12 and PACS-70 fluxes allows the identification of transitional disks with Herschel data (Ribas et al. [2013])

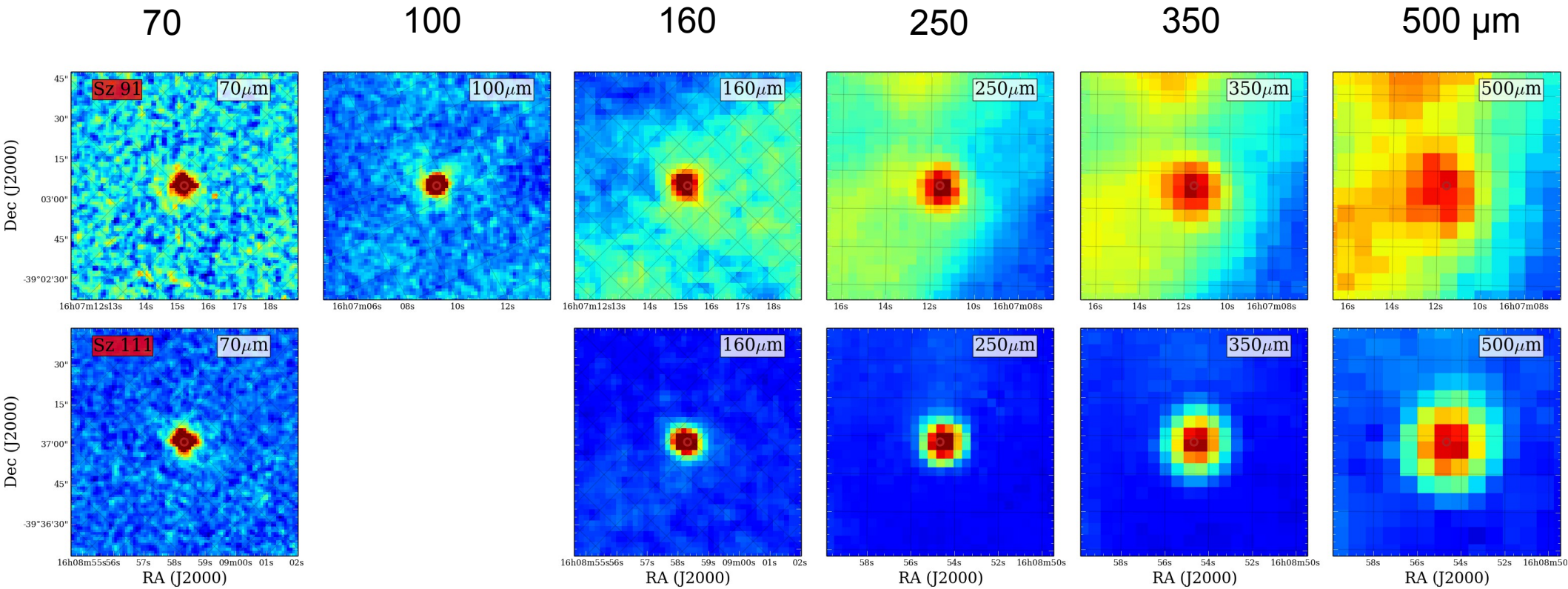
Herschel data



Our 2MASS + WISE + Herschel selection criteria finds two already known transitional disks in Lupus

Herschel Gould's Belt Survey (PI: Ph. André)

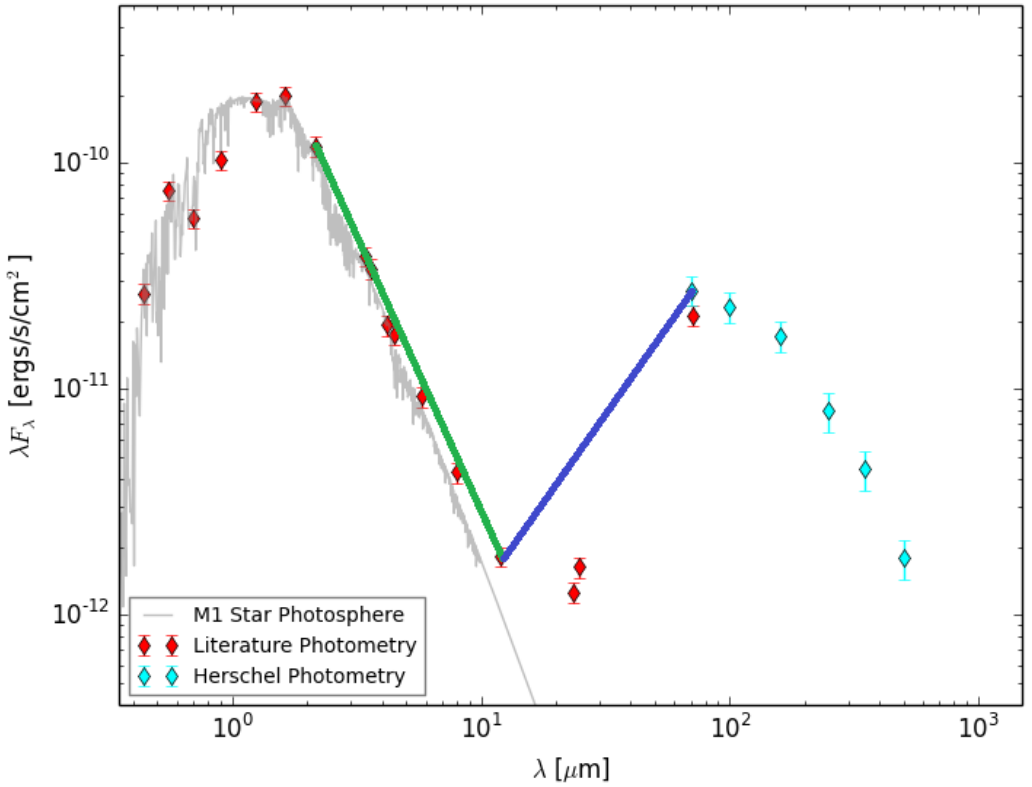
Herschel detections in Lupus



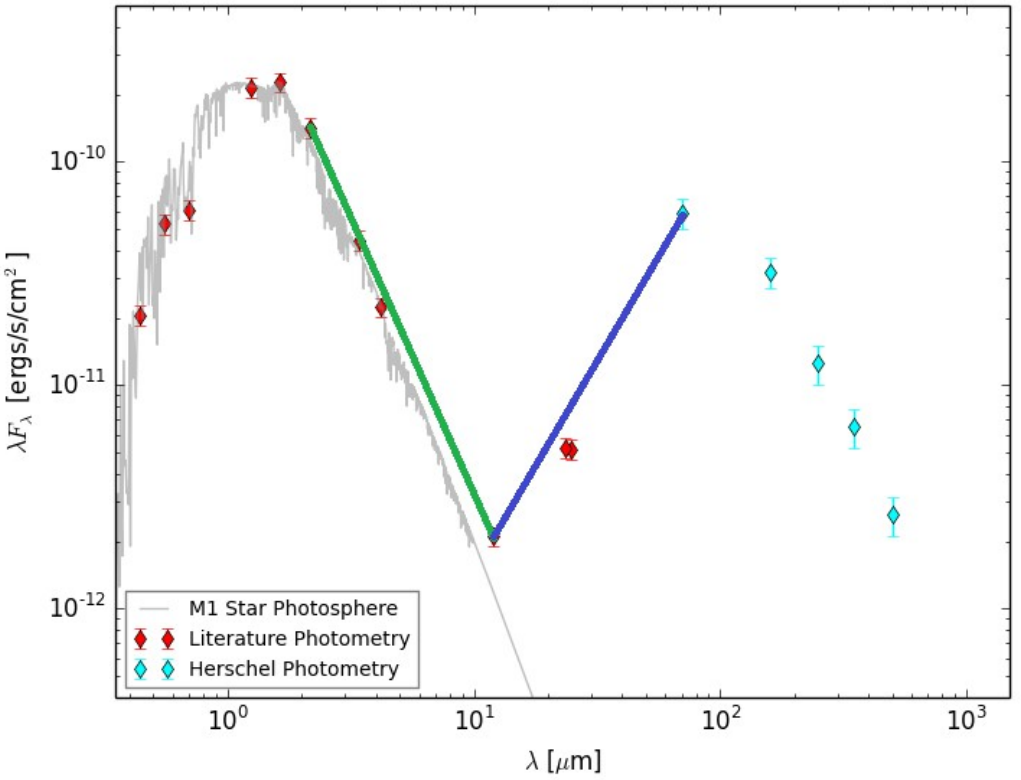
Parameters	Sz 91	Sz 111
RA	16:07:11.59	16:08:54.69
Dec	-39:03:47.54	-39:37:43.11
Sp Type	M 1.0	M 1.5
Temperature (K)	3785	3650
Mass ($M_\odot$)	0,75	0,66

Physical interpretation

Sz 91



Sz 111

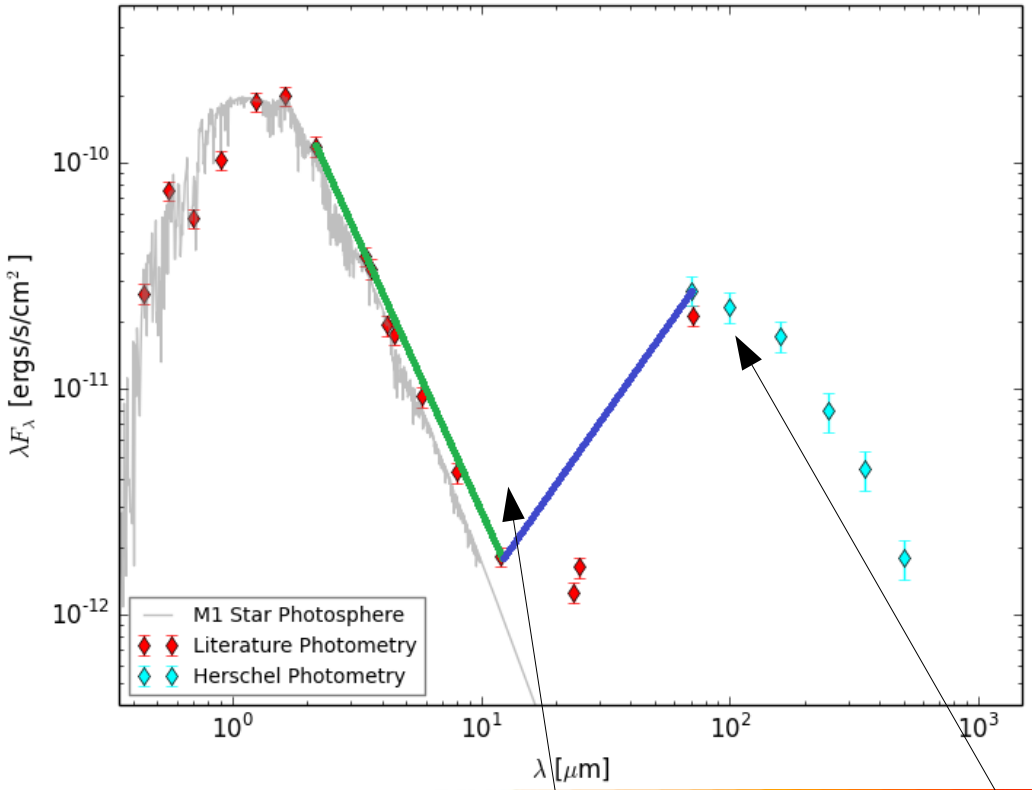


Ancillary Data – **Optical, 2Mass, WISE, Spitzer**

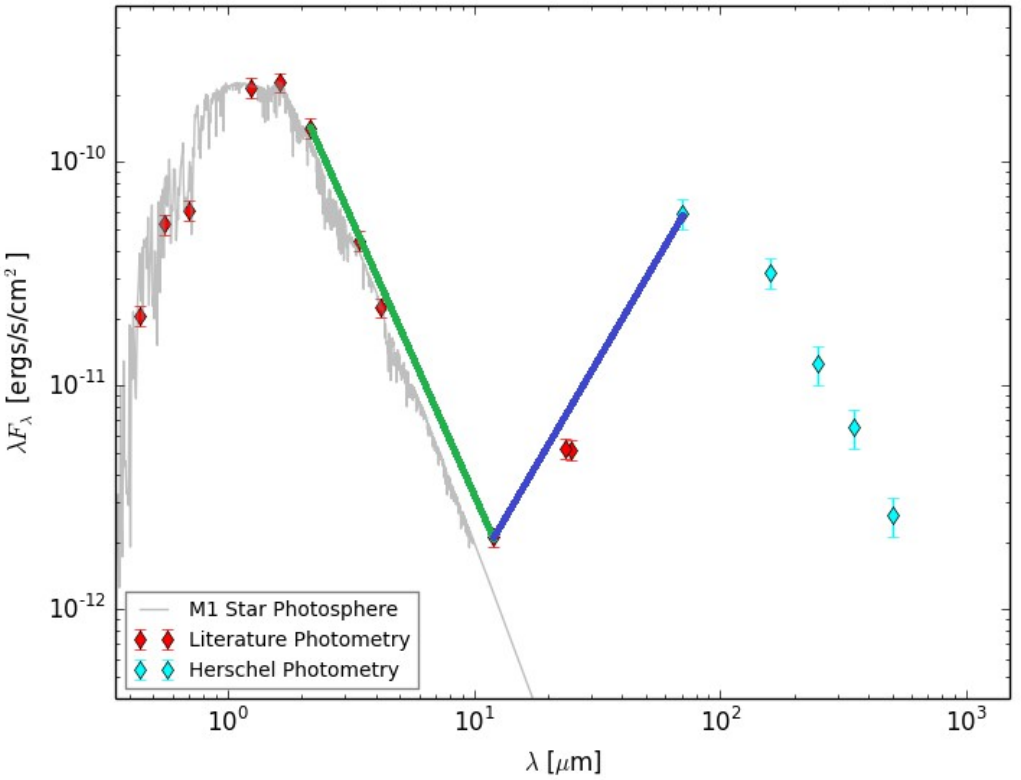
New Herschel Data – **PACS, SPIRE**

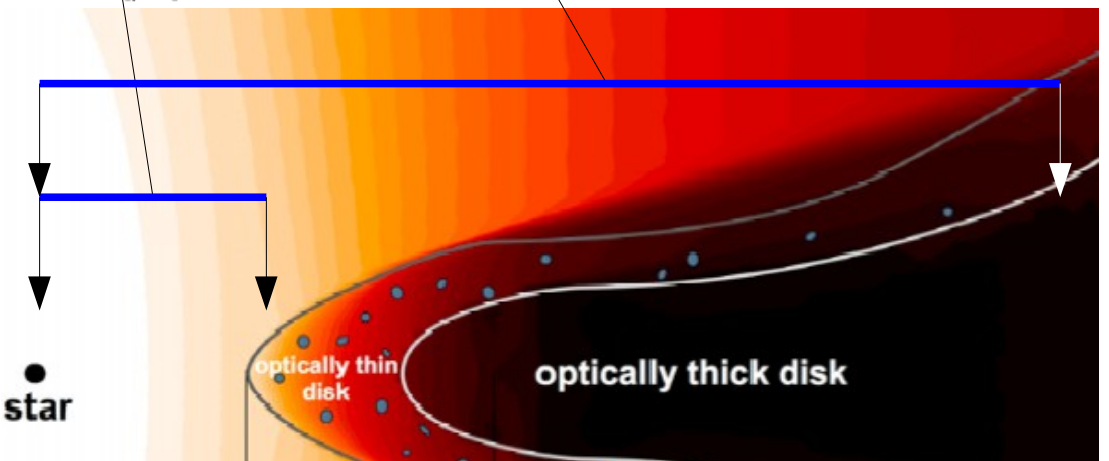
Physical interpretation

Sz 91



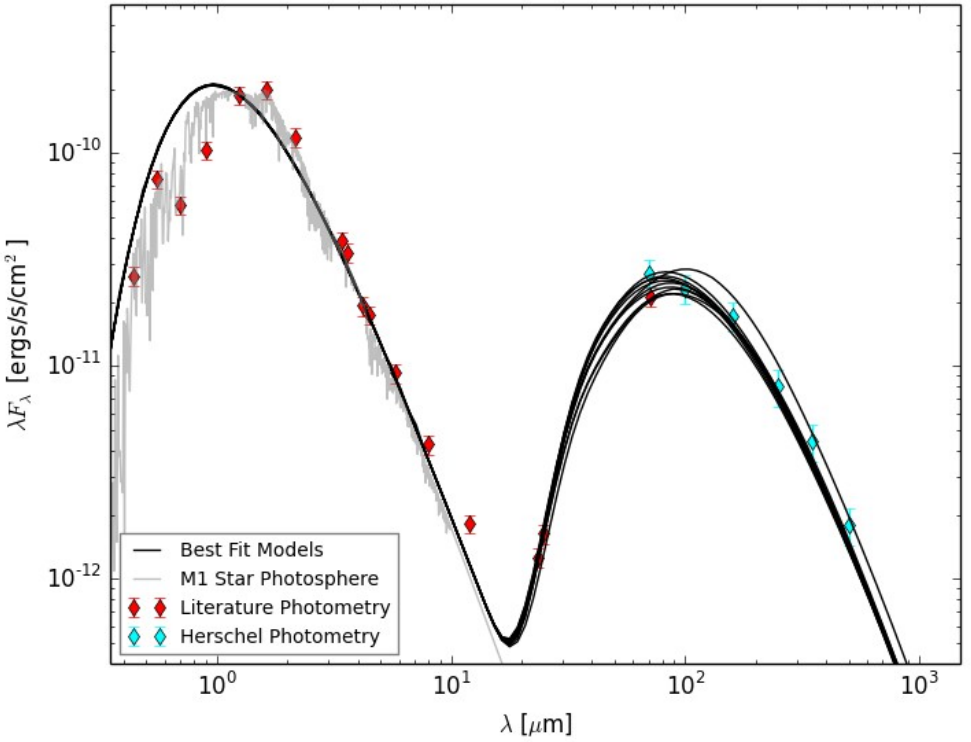
Sz 111





Disk models

Sz 91



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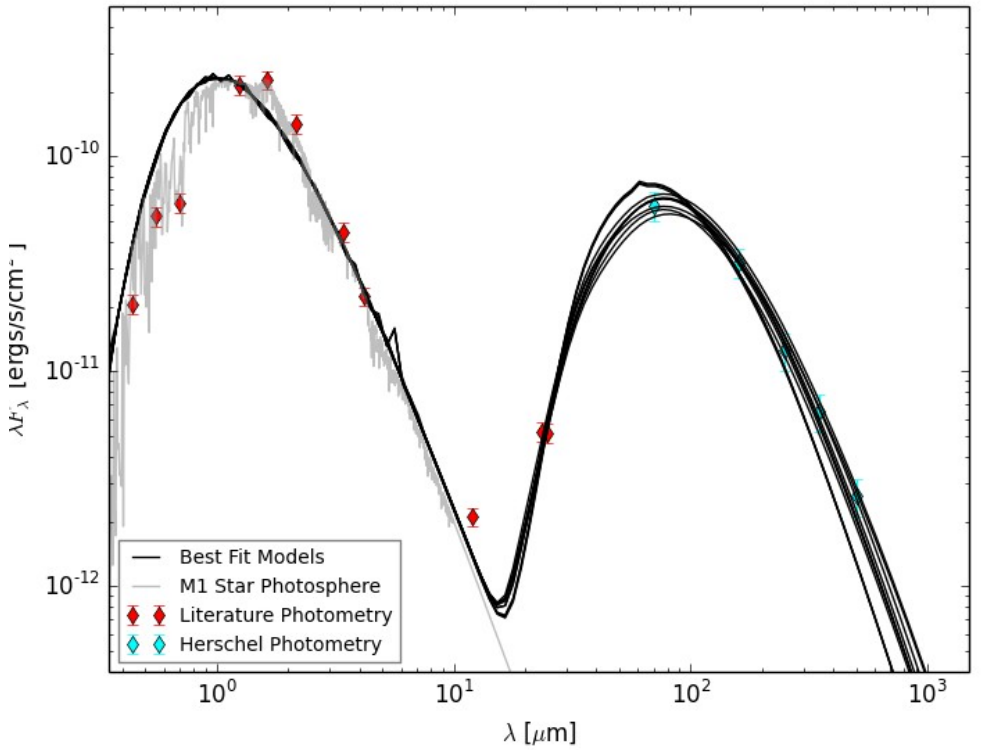
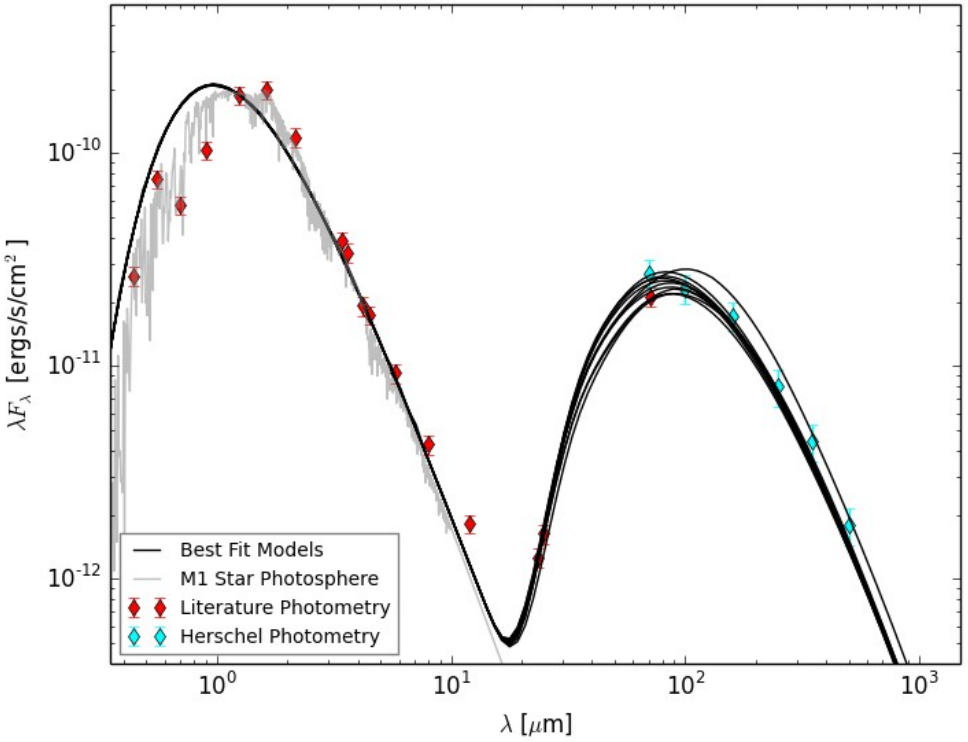


Parameters	Values sampled by grid	Sz 91	Sz 111
M_{dust} (M_*)	[0.001 – 0.009]	undetermined	undetermined
R_{in} (AU)	[20 - 100]	[40 - 80]	[35 - 60]
R_{out} (AU)	[25 - 100]	[< 70]	[40 - 70]
Surface density profile	[-0.5 - -1.75]	undetermined	undetermined
Inclination (º)	[0 - 90]	undetermined	undetermined

Hyperion - radiative dust transfer code – Robitaille et al. (2011)

Disk models

Sz 91



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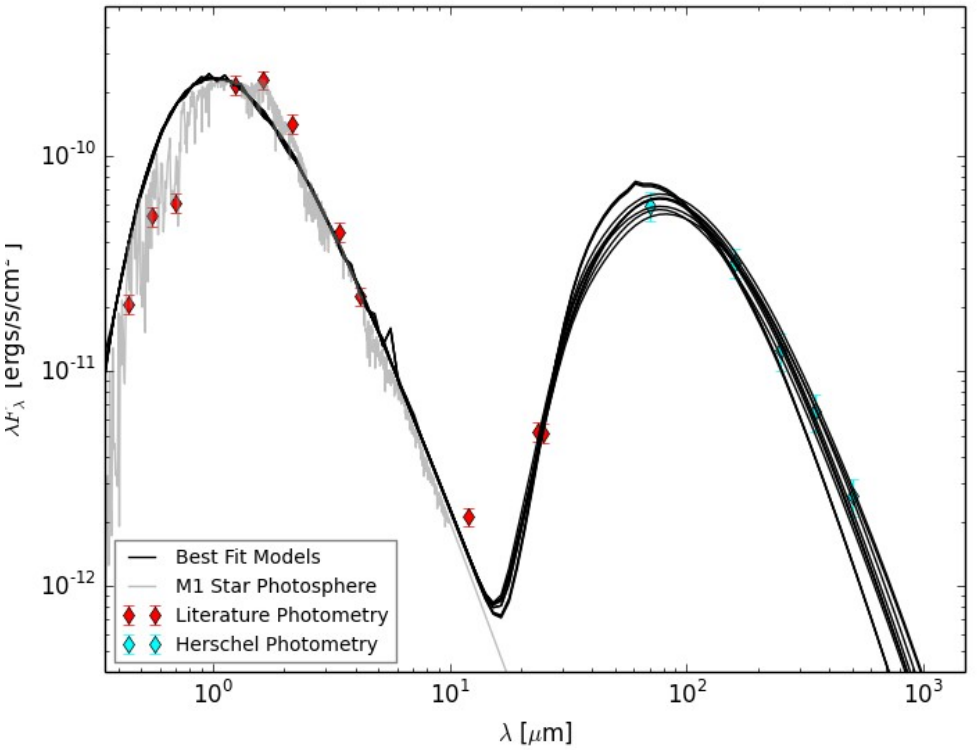

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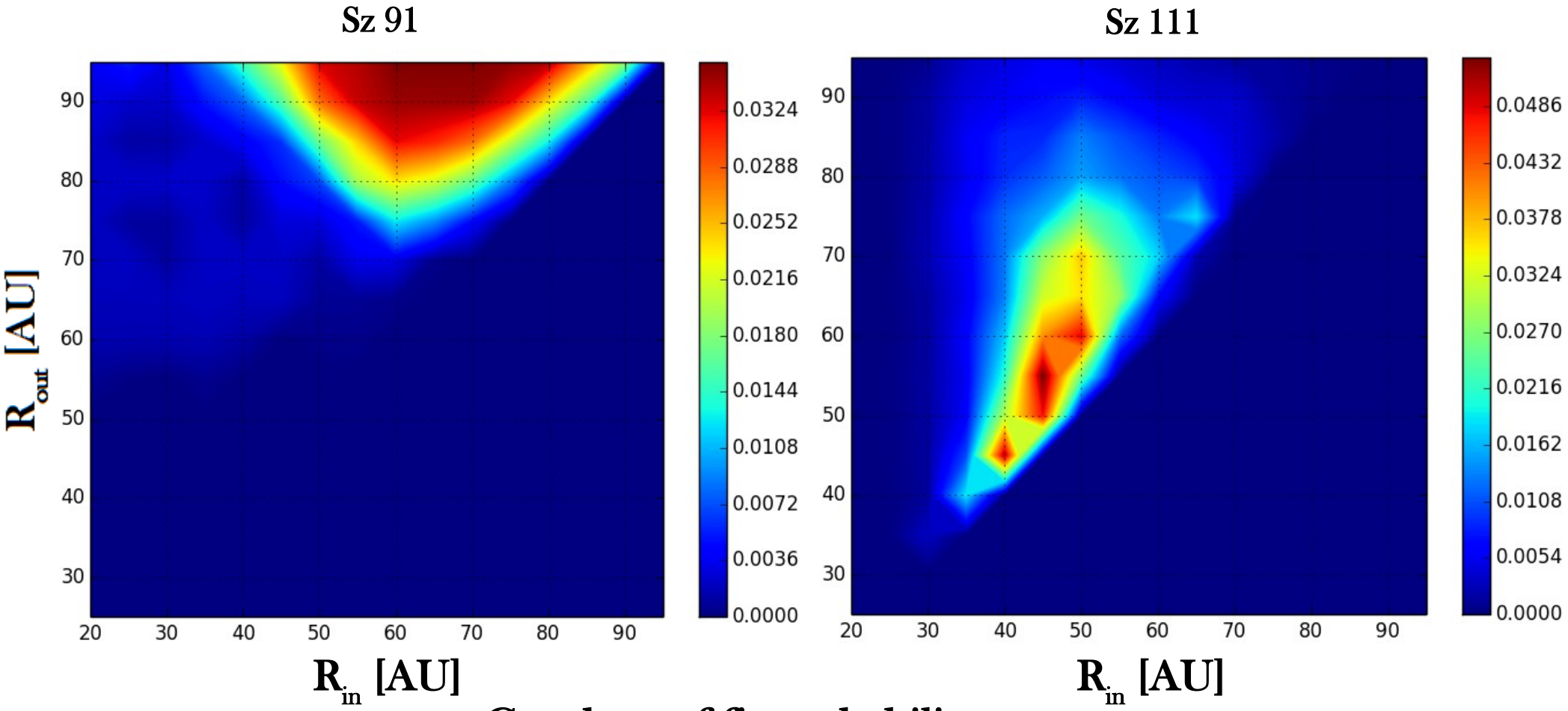
Two parameters constrained

Hyperion - radiative dust transfer code – Robitaille et al. (2011)

Constraining the outer disk



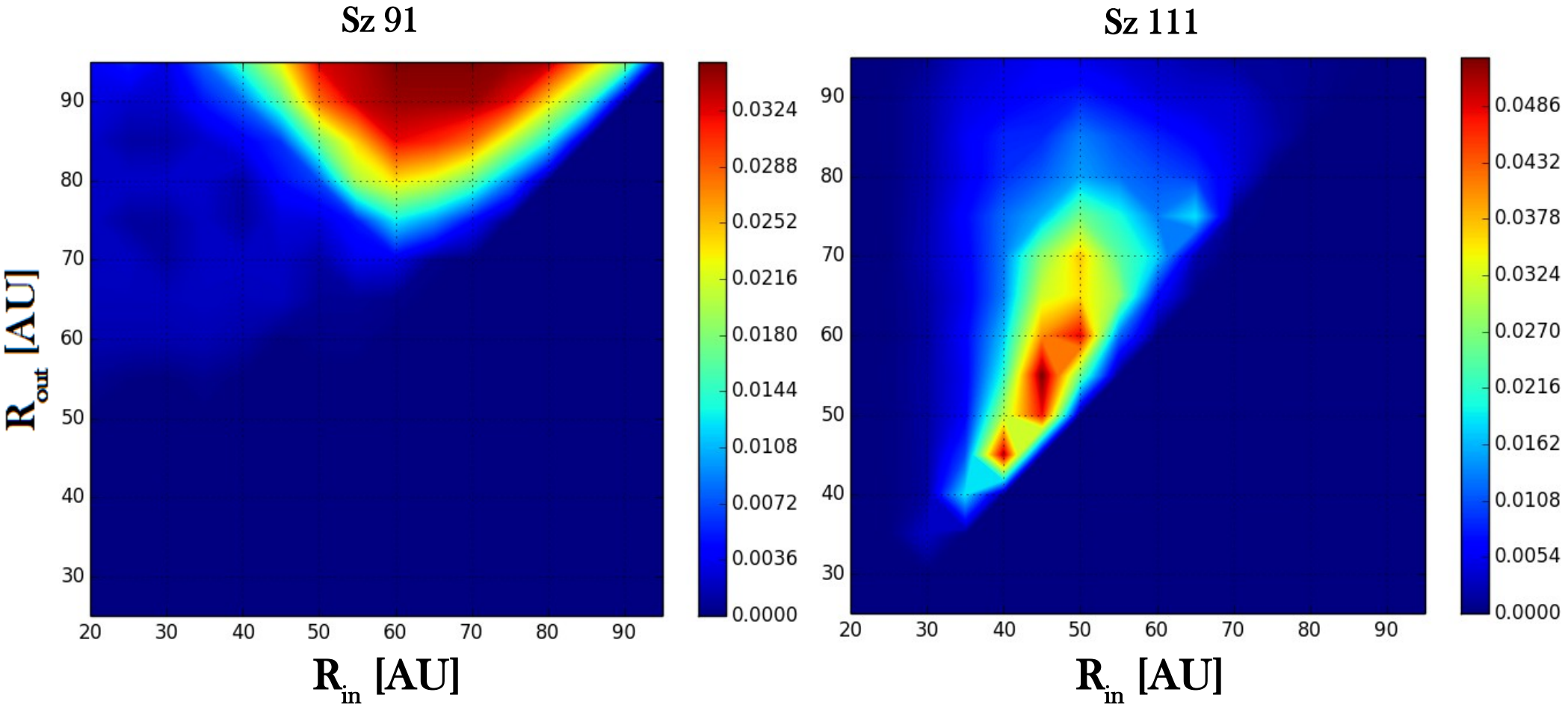
Goodnes of fit probability maps:

- Inner radius constrained for both objects → large inner hole
- Outer disk constrained for Sz 111

Ongoing process

Hyperion - radiative dust transfer code – Robitaille et al. (2011)

Constraining the outer disk



Motivation: Cieza et al. (2011) on another transitional disk (T Cha)

→ Outer disk very small

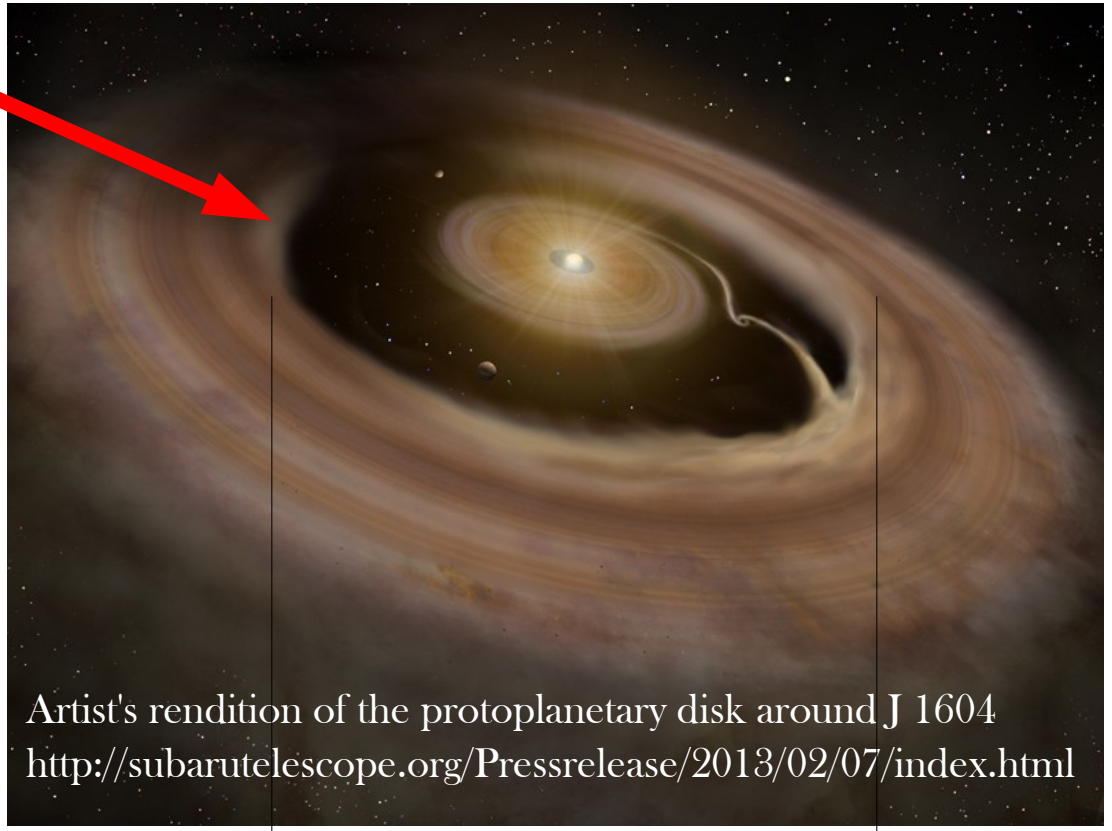
or

→ Outer disk very tenous

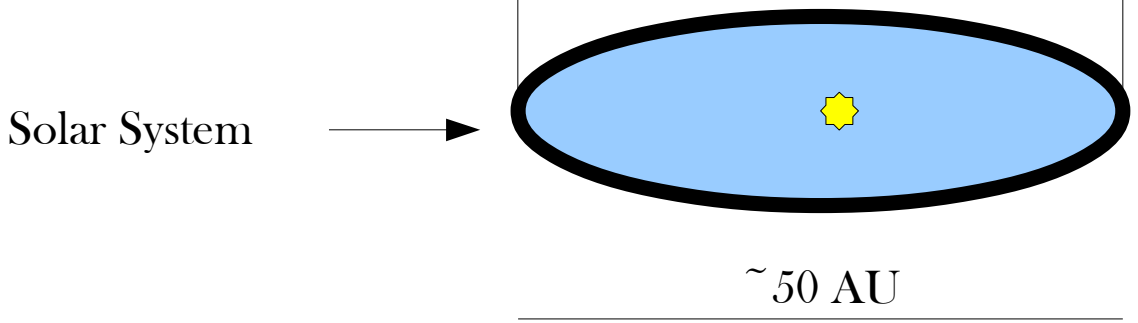
Hyperion - radiative dust transfer code – Robitaille et al. (2011)

Overall interpretation of the system

Facts
Large inner holes



Artist's rendition of the protoplanetary disk around J 1604
http://subarutelescope.org/Pressrelease/2013/02/07/index.html



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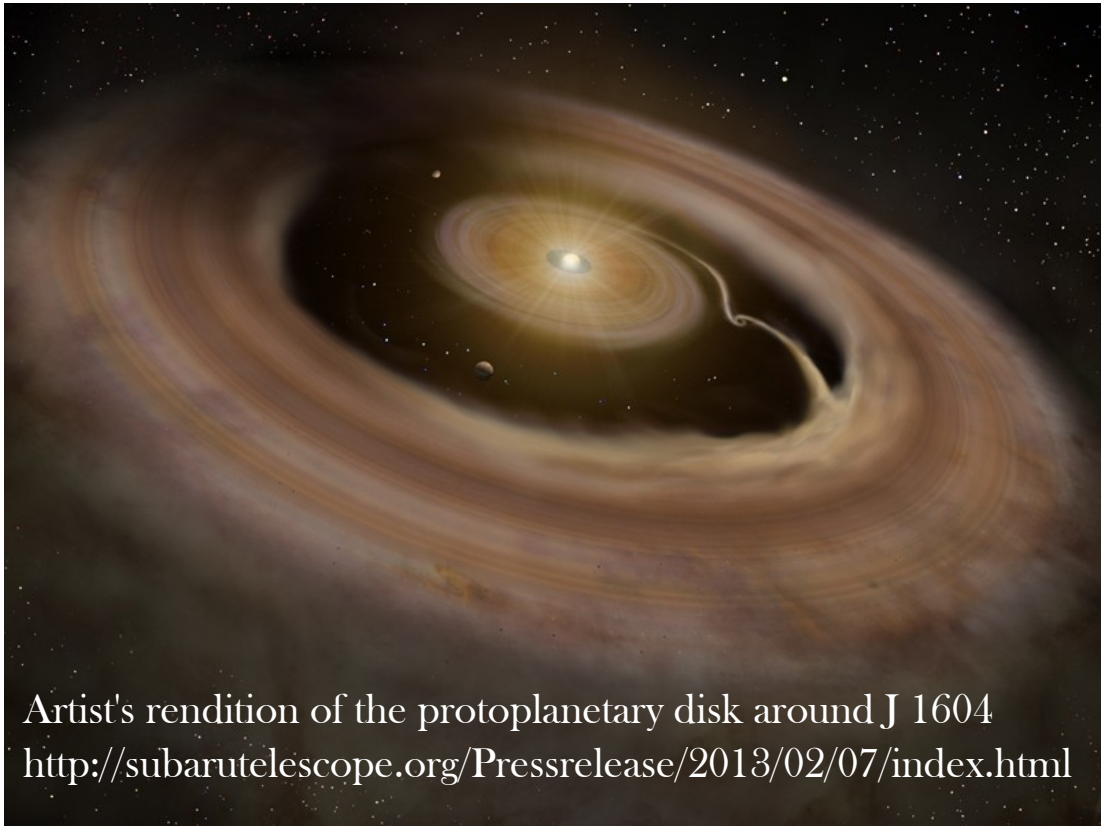

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Overall interpretation of the system

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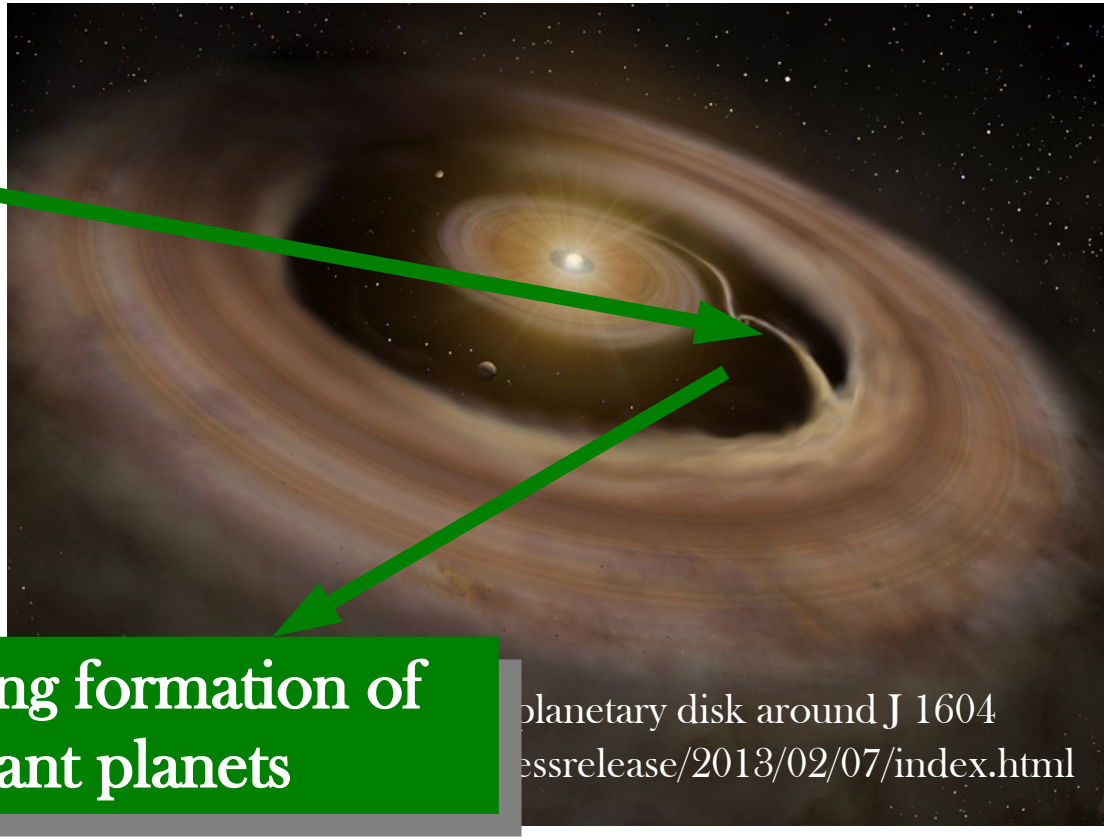
Small outer disk (Sz 111)
Gas accretion to the star (Hughes et al., 1994)



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Ongoing formation of giant planets

Conclusions and Future Work

Results

- Transitional disk detection method tested

- Two objects confirmed in Lupus cloud – Sz 91 and Sz 111

- SED modelling allows to constrain sizes of circumstellar disks → they present **large inner holes** and, in one case, narrow outer rings

- Large inner holes and accretion to the stars hint at **ongoing giant planet formation** on these systems

Future work

- Finalize analysis

- Submit A&A letter

- **ALMA** follow-up observation and preparation to **JWST**