Debris disks around nearby stars

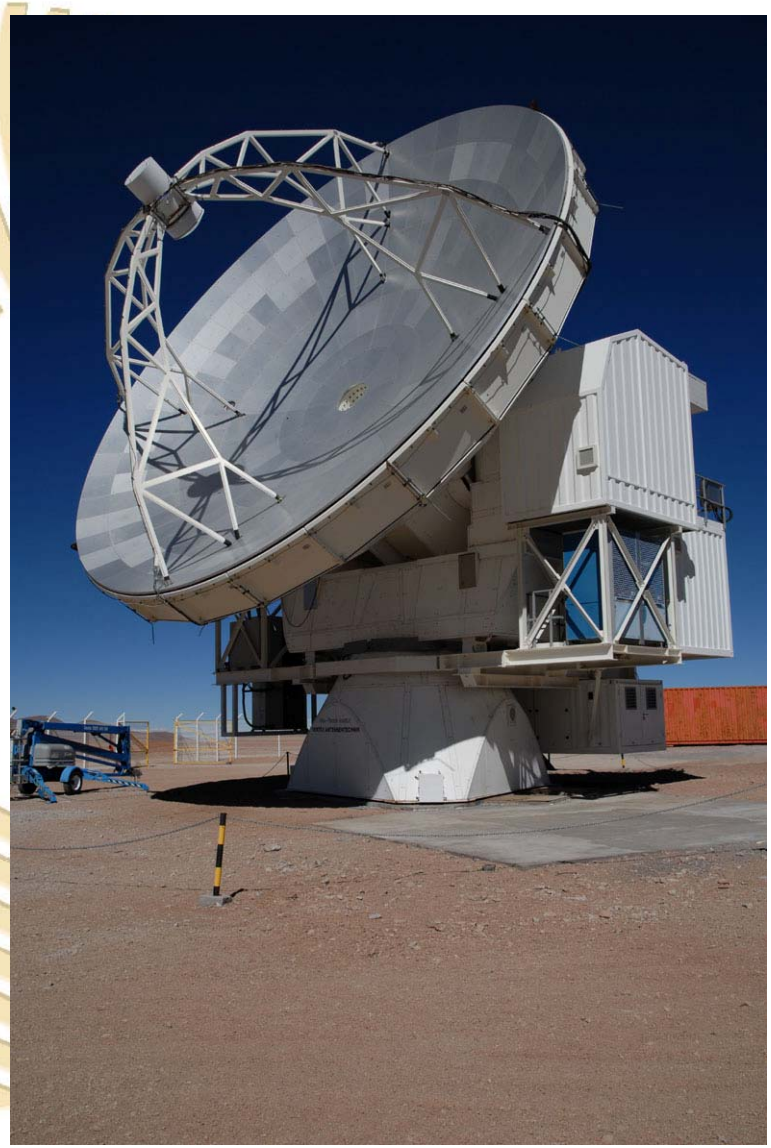
Inter-Dept'l Science (SRE-S/O) Workshop

ESTEC, Thu-Fri 28-29 August 2008

Göran Pilbratt, Jens Rodmann,
Ana Heras & Malcolm Fridlund

Presentation overview

- What are debris disks?
  - What they are not?
  - What they are!
- Early days
  - IRAS
  - ISO, SCUBA, Spitzer
- Why are debris disks interesting?
- What are we doing?
- Way forward



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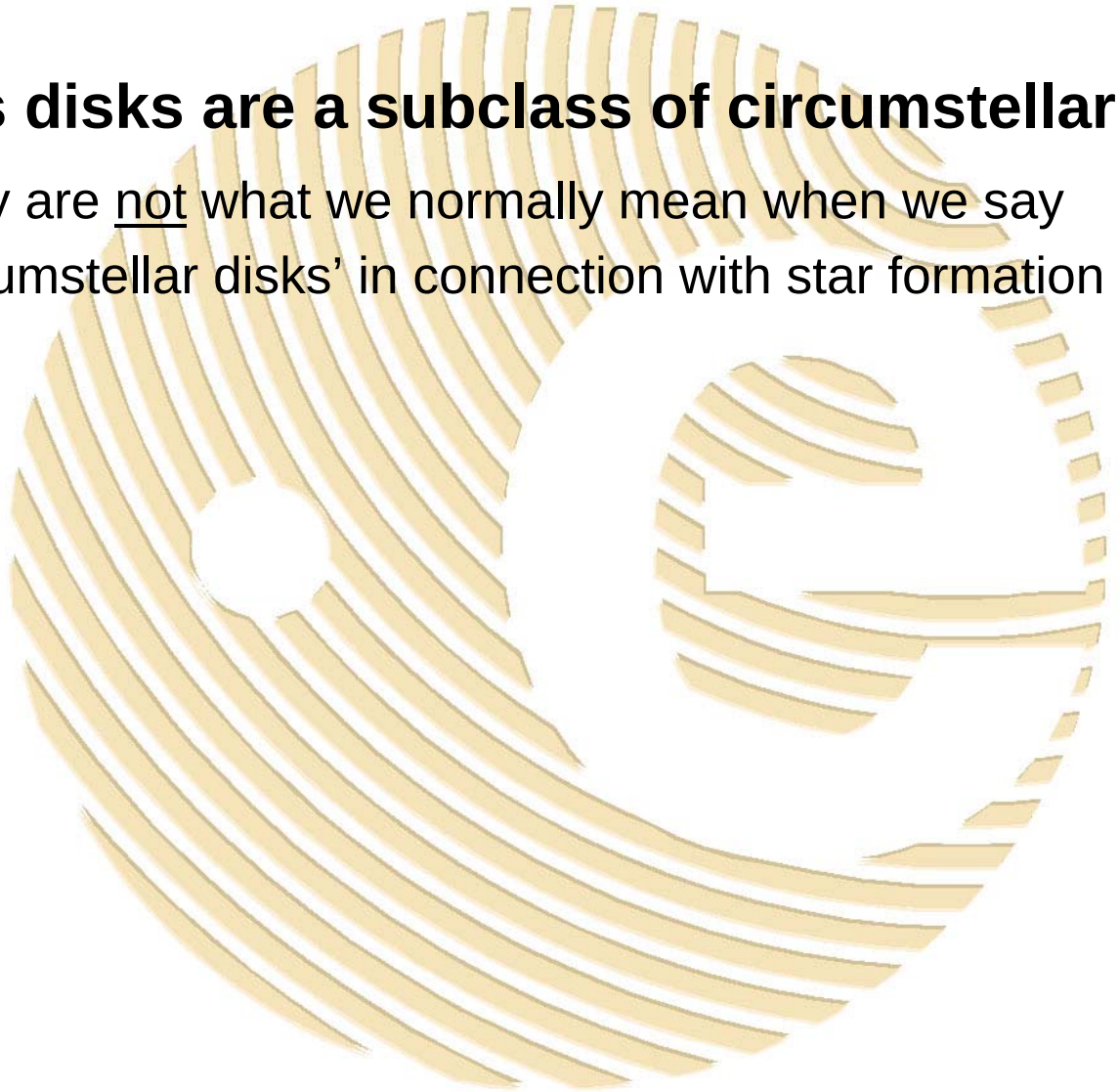
What are debris disks?

- **Debris disks are a subclass of circumstellar disks**
  - They are <u>not</u> what we normally mean when we say ‘circumstellar disks’ in connection with star formation



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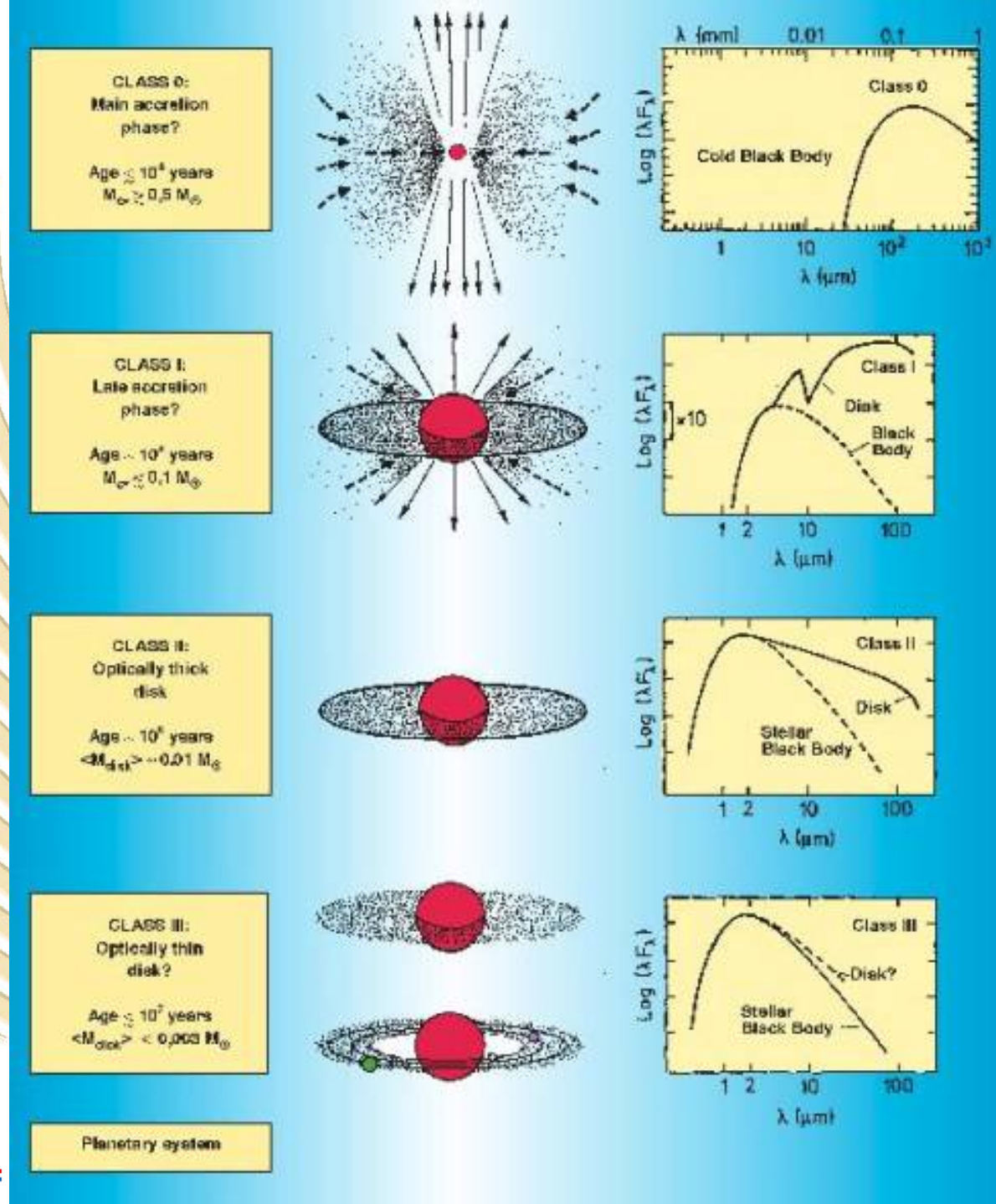
Naïve picture of (low mass) star formation

➔

- This is <u>not</u> the kind of circumstellar disks we are talking about!
- These are
  - gas dominated,
  - short lived
- Short lifetime taken to indicate planetary formation
- Cf. Bruno Merin's Spitzer talk



What are debris disks?

- **Debris disks are a subclass of circumstellar disks**
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- **Debris disks are ‘secondary’ disks, aka**
  - Circumstellar debris disk systems
  - Second generation dust disks/clouds
  - Planetary debris disk systems
  - Vega-type objects
- **Nature of debris disks**
  - Debris disks seen through IR excess – dust emission
  - Large bodies – planets – do not cause (enough) IR excess

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Debris disks early days

- **IRAS observations of main sequence stars => infrared excess discovered**
  - ~15% of nearby stars show debris disks
- **The ‘Fab four’**
  - β Pictoris – A5 IV, ‘young’
  - Fomalhout – A3 V, ~100 Myr
  - Vega – A0 V, ~350 Myr
  - ε Eridani – K2 V, ~800 Myr

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- **ISO observations**
  - Habing - disks decay in ~400 Myrs
  - Decin - 5 out of 60 show IR excess, all probably older than ~3 Gyrs
- **JCMT/SCUBA observations**
  - Holland Nature paper (cover!)
- **Spitzer observations**
  - CS disks one of four defining science drivers, lots of papers

Why are debris disks interesting?

- **'Secondary' – in need of continuing replenishment**
  - Dust destruction
  - Gravitational forces
  - Radiation pressure forces
    - Absorption and scattering
    - Poynting-Robertson drag
  - Solar wind (particle) forces – 'pseudo-PR drag'
- **➔ finite lifetime of dust <<< stellar lifetime**
- **➔ source of 'mother material' for replenishment**
  - Like in the solar system planetesimals are the major source
  - Inference of existence planets unclear

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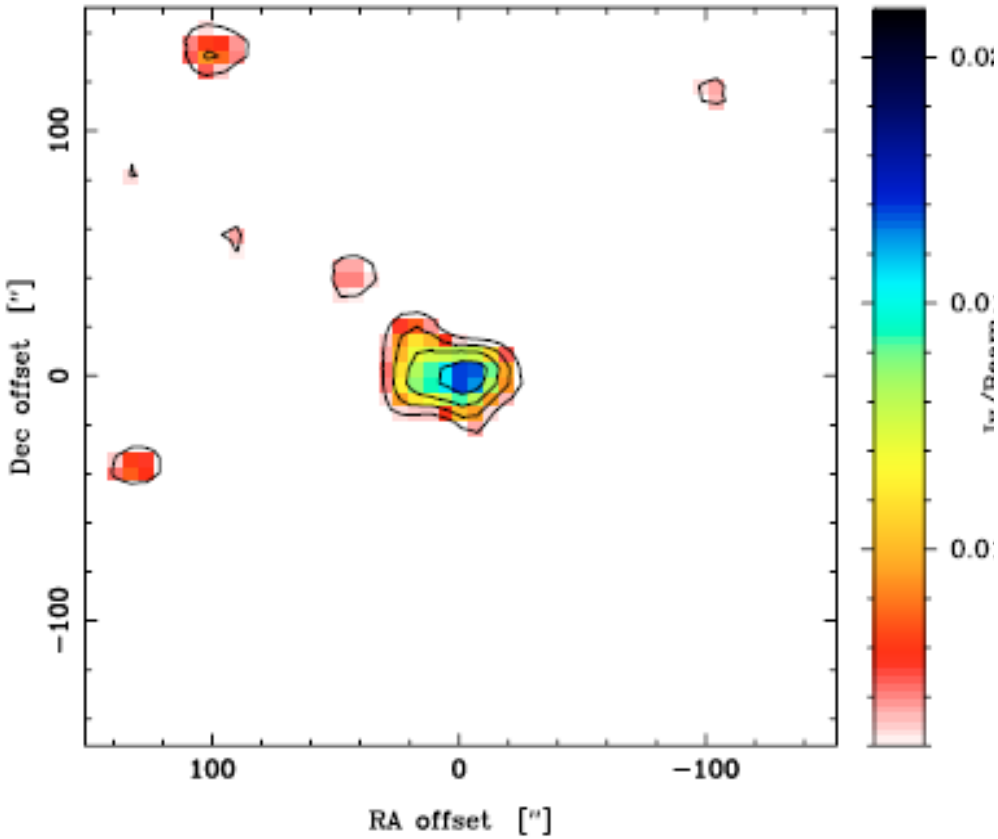
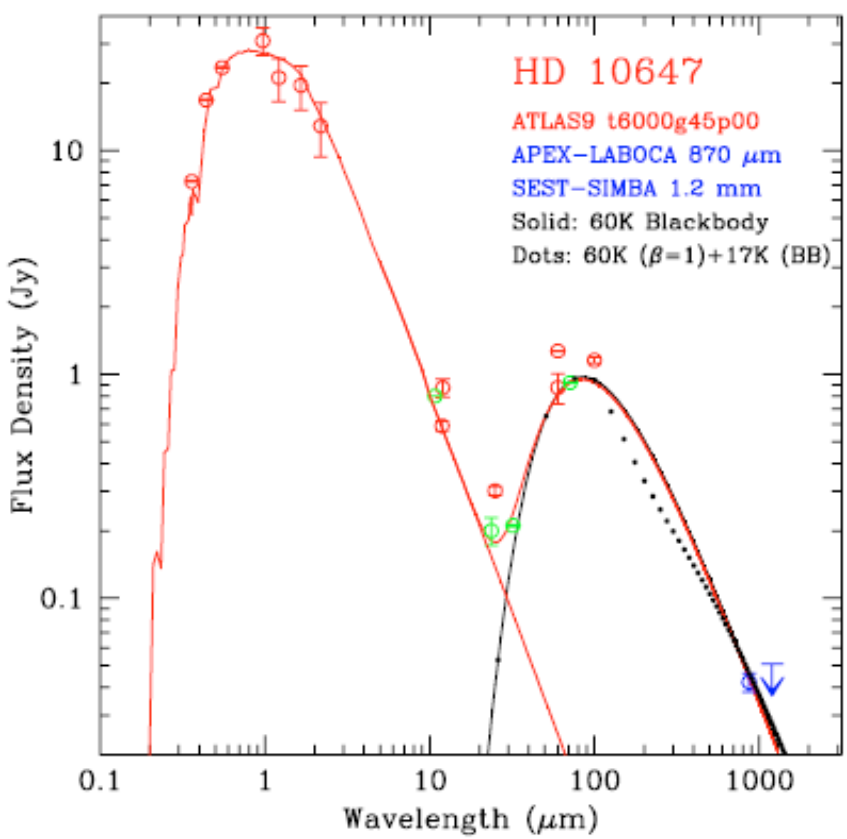
Debris disks questions?

- **Possible tip of the iceberg situation**
  - Limited wavelength coverage, sensitivity, angular resolution
  - What is the true incidence of debris disks?
- **Proxy for the existence of planetary systems?**
  - Possible problem for direct observations (DARWIN)
- **Future programmes**
  - Herschel programmes – DUNES & DEBRIS (+ CS)
  - **Authors are members of DUNES consortium**
    - observations in the future
  - JCMT/SCUBA2 & APEX/LABOCA/SABOCA
  - **Authors are members of APEX consortium**
    - **observations ongoing**

APEX observations

- **Initial observations**
  - Atacama Pathfinder Experiment
  - Llano de Chajnantor at ~5100 m
  - LABOCA bolometer array at 870 μm





A&A 480, L47–L50 (2008)
DOI: 10.1051/0004-6361:20079276

Astronomy & Astrophysics

LETTER TO THE EDITOR

q[1] Eridani: a solar-type star with a planet and a dust belt⋆

R. Liseau[1], C. Risacher[2], A. Brandeker[3], C. Eiroa[4], M. Fridlund[5], R. Nilsson[3], G. Olofsson[3], G. L. Pilbratt[5], and P. Thébault[3,6]

HIGHLIGHTS: this week in A&A

Volume 480-3 (March IV 2008)

In section 1. Letters

"q1 Eridani: a solar-type star with a planet and a dust belt", by R. Liseau et al., A&A 480, p. L47

There is to date only one main sequence star (ε Eridani) associated with having both planets and enough circumstellar dust to be observable at far infrared /submm wavelengths. Liseau and collaborators report in this letter the detection, with the LABOCA instrument on the APEX telescope, of cold dust around the star q1 Eridani, which has an associated Jupiter-mass planet. The authors conclude that there are about 3 Moon masses of mm-sized grains in a belt roughly 300 AU from the star.

APEX observations

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  - Atacama Pathfinder Experiment
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  - Observations in August 2007 – A&A 2008
- **➔ so we got more time ...**
  - 200 hours in 2008 & 2009
  - … so far 59 hours in 2008
- **… and I was sent to observe …**

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- **… and I was sent to observe …**
  - We have observed 11 stars
  - … and have detected 8 of them

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Herschel observations

- **DUNES programme**
  - Herschel Open Time Key Programme – 140 hours
  - Photometry of a large sample of nearby (d<20 pc) FGK stars
  - PACS at 100 and 170 μm
  - SPIRE at 250, 350, and 500 μm follow-up for selected targets
  - Complementary to DEBRIS programme
- **Science Objectives**
  - Herschel as finder of faint exo-EKBs
  - Dependence of planetesimal formation on stellar mass
  - Collisional and dynamical evolution of exo-EKBs
  - Presence of exo-EKBs vs presence of plantes?
  - Dust properties and size distribution in exo-EKBs

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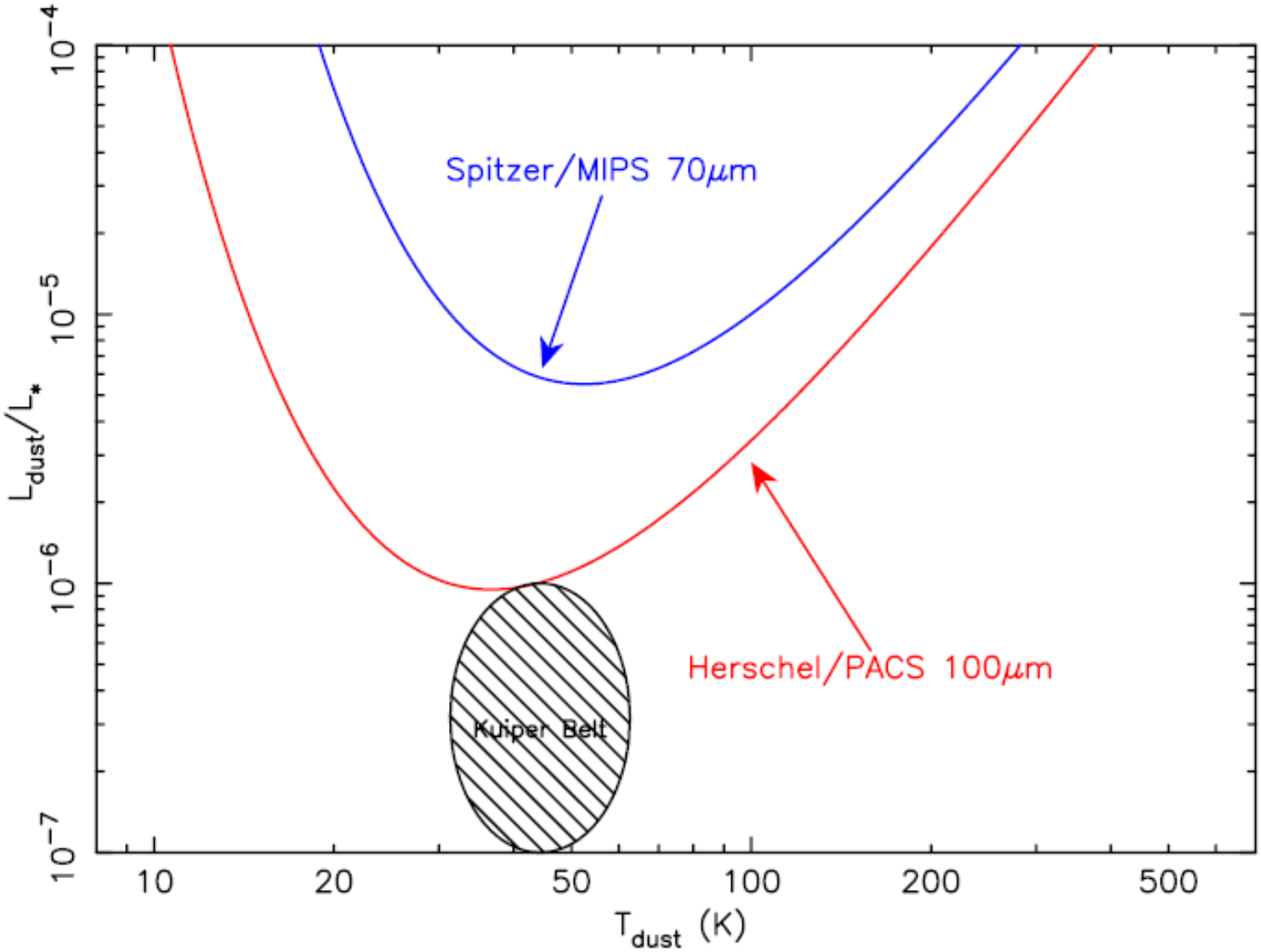
Herschel observations



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