Young Debris Disks with Herschel

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and the Herschel GASPS Team

Gas in Protoplanetary Systems (GASPS)

Herschel PACS Open Time Key Programme to study the evolution of gas and dust in protoplanetary and debris disks

PI – Bill Dent

240 targets

Ages: 1 – 30 Myrs

Spectral types B - M

Observations

Photometry: 70 and 160 μm

Spectroscopy: [OI], [CII], ...

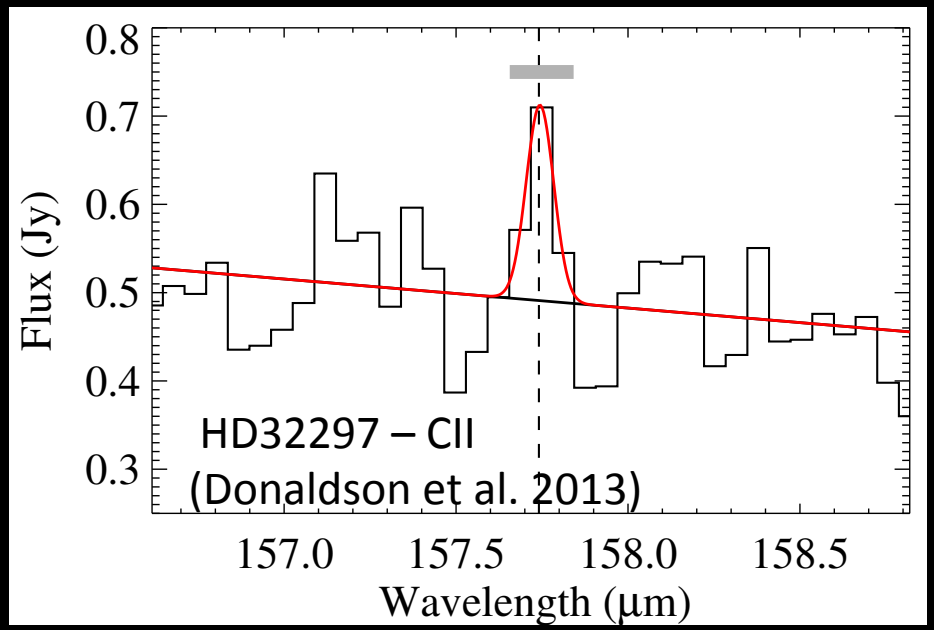
Young Debris Disks in GASPS

- Survey of 68 stars, 10-30 Myrs old
  - Debris disk phase, little to no gas
- Goal: to look for trends in disk parameters with stellar properties and/or age
- Result: found a trend between disk temperature and stellar temperature

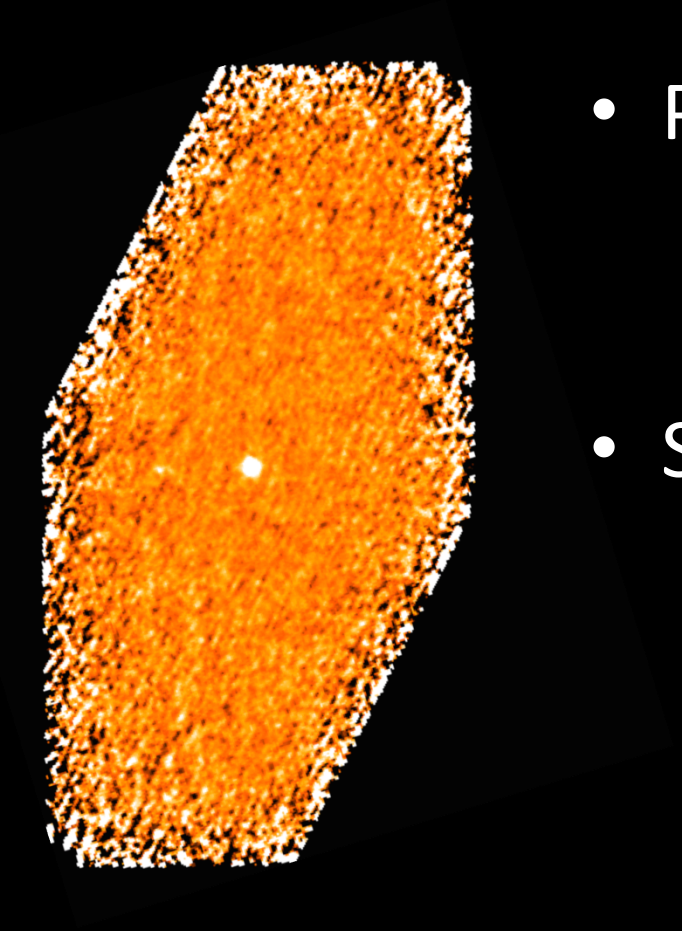
Gas in Debris Disks

- Gas detected in 3 debris disks
  - HD172555, [OI] (Riviere-Marichalar 2012)
  - 49 Ceti, [CII] (Roberge et al. 2013)
  - HD32297 [CII] (Donaldson et al. 2013)

- Focus on photometry

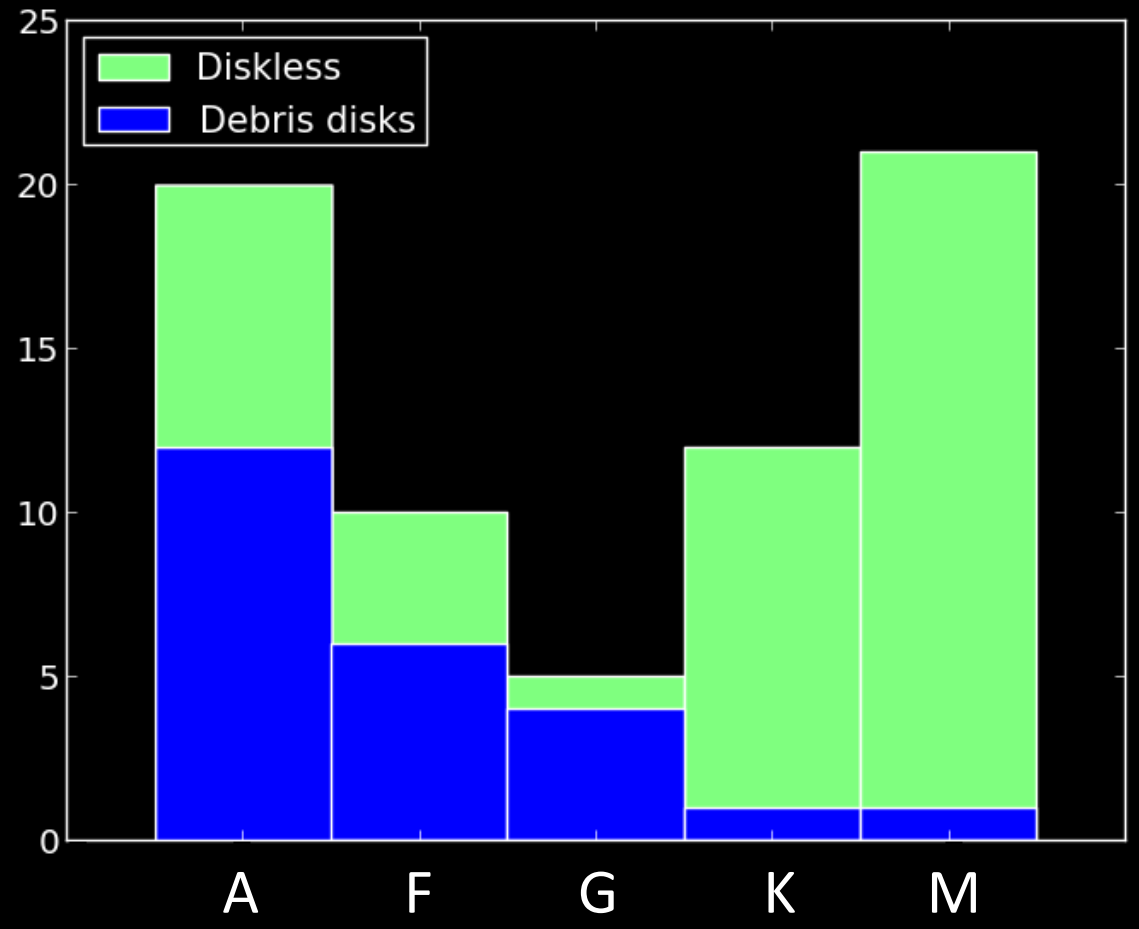


Photometry Data



- PACS 70, 100, 160 μm
  - All targets
- SPIRE 250, 350, 500 μm
  - Follow up of disks detected by PACS
    - (OT2: PI A. Roberge)
  - Detected ~1/4

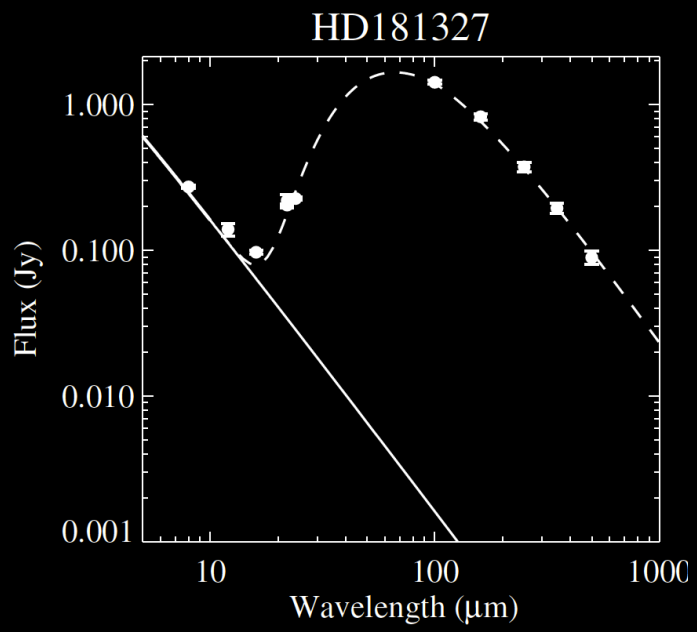
Debris Disks from the GASPS Sample
68 Stars, 24 Disks, 10-30 Myrs old



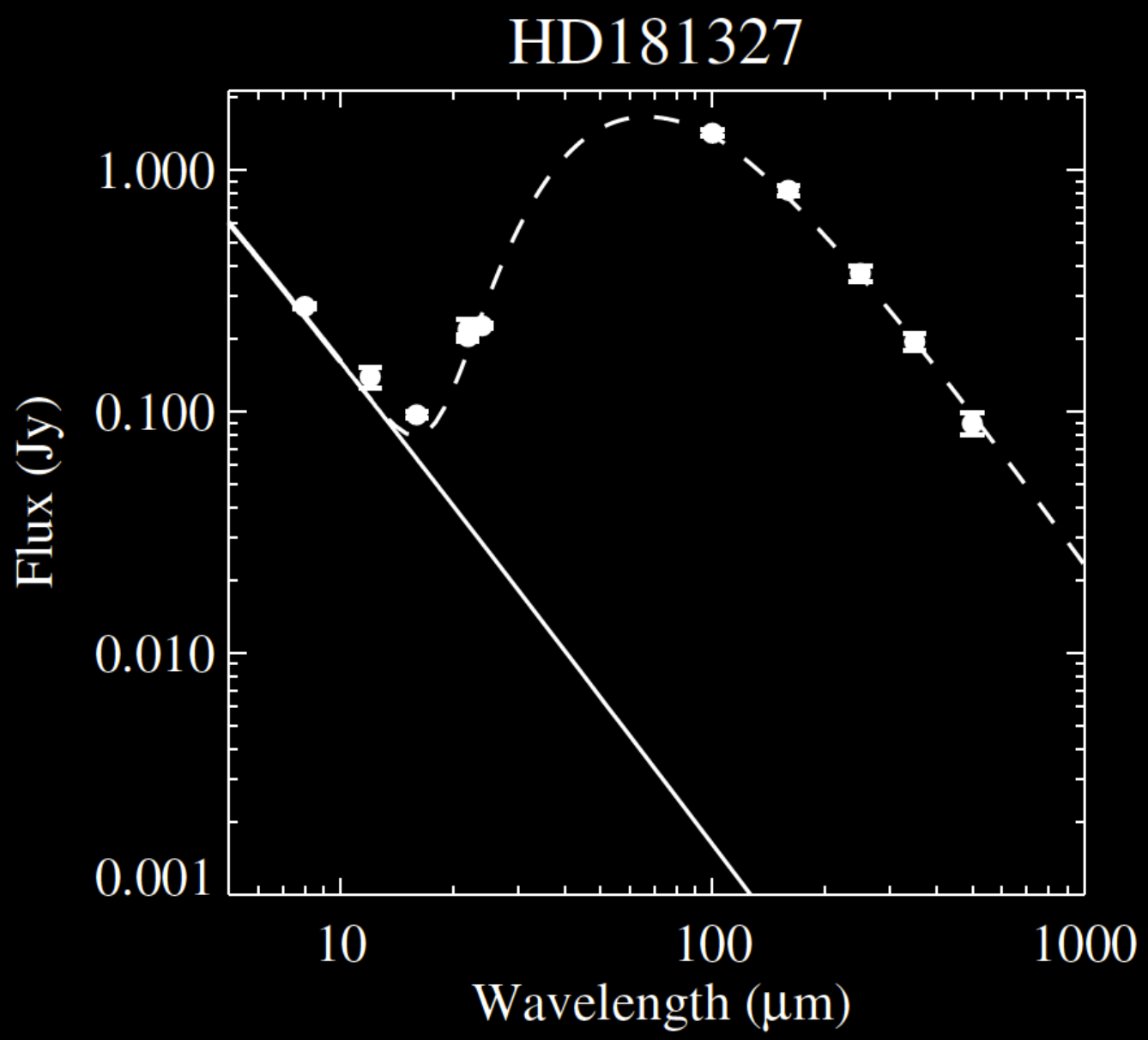
TW Hydrae Association
8 - 10 Myrs
Upper Scorpious
5 - 11 Myrs
β Pictoris Moving Group
12 - 22 Myrs
Tucana-Horologium
30 Myrs

Archive Data & Photosphere Fitting

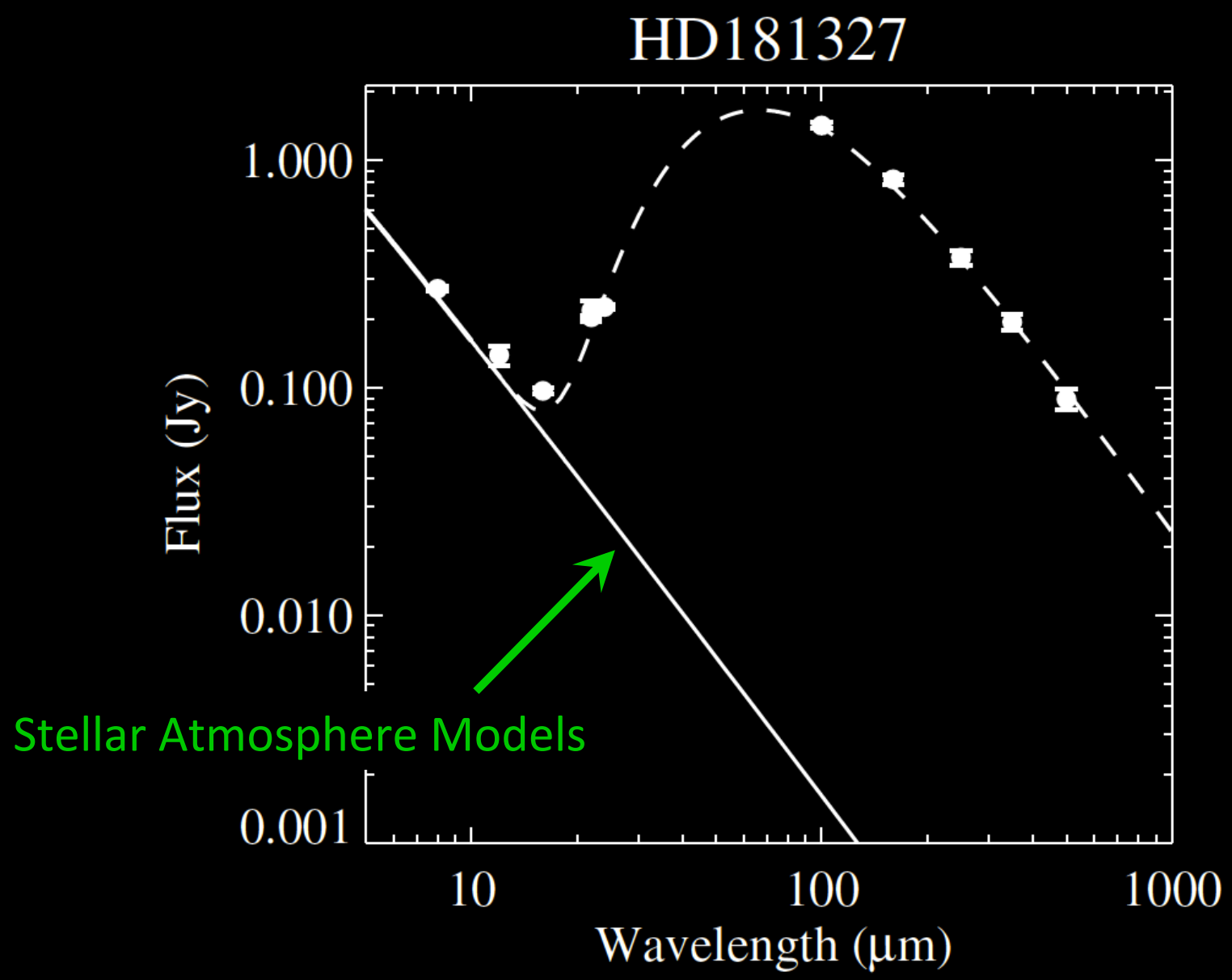
- Collected Archive Data
  - Hipparcos
  - 2MASS
  - WISE
  - Spitzer
- Stellar Photosphere Fitting
  - Kurucz or NextGen Stellar Atmosphere models



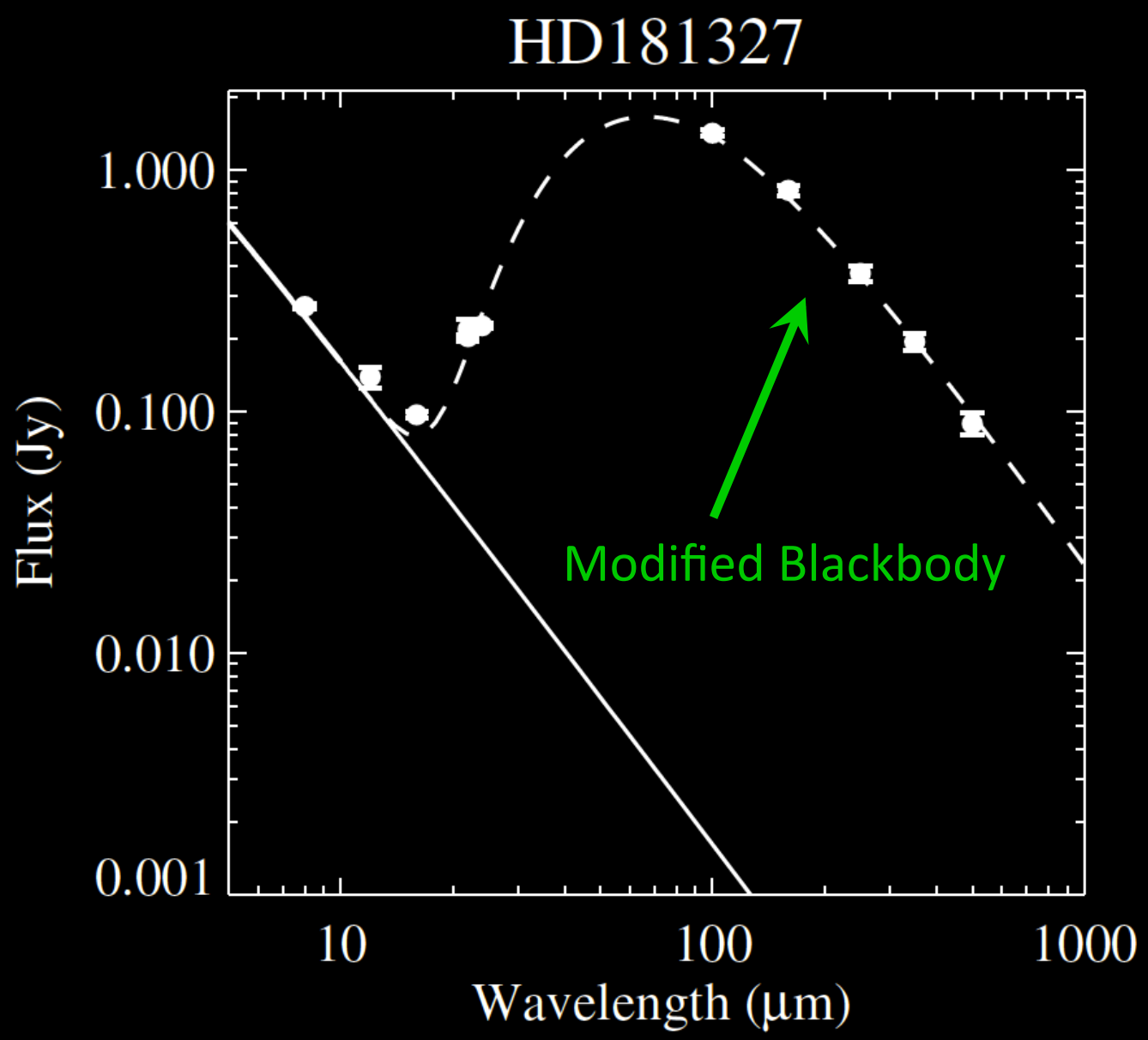
Spectral Energy Distribution Fitting

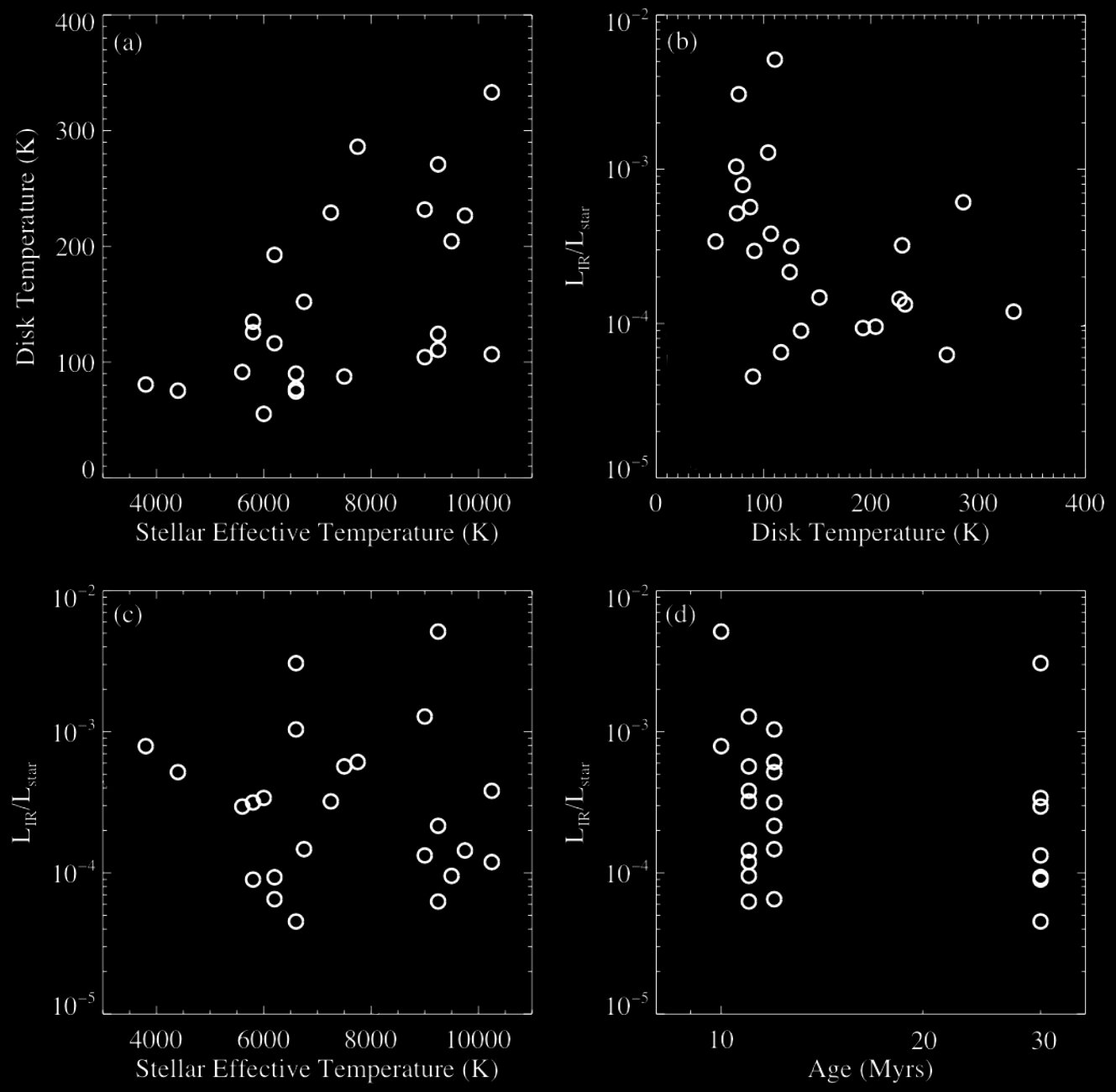


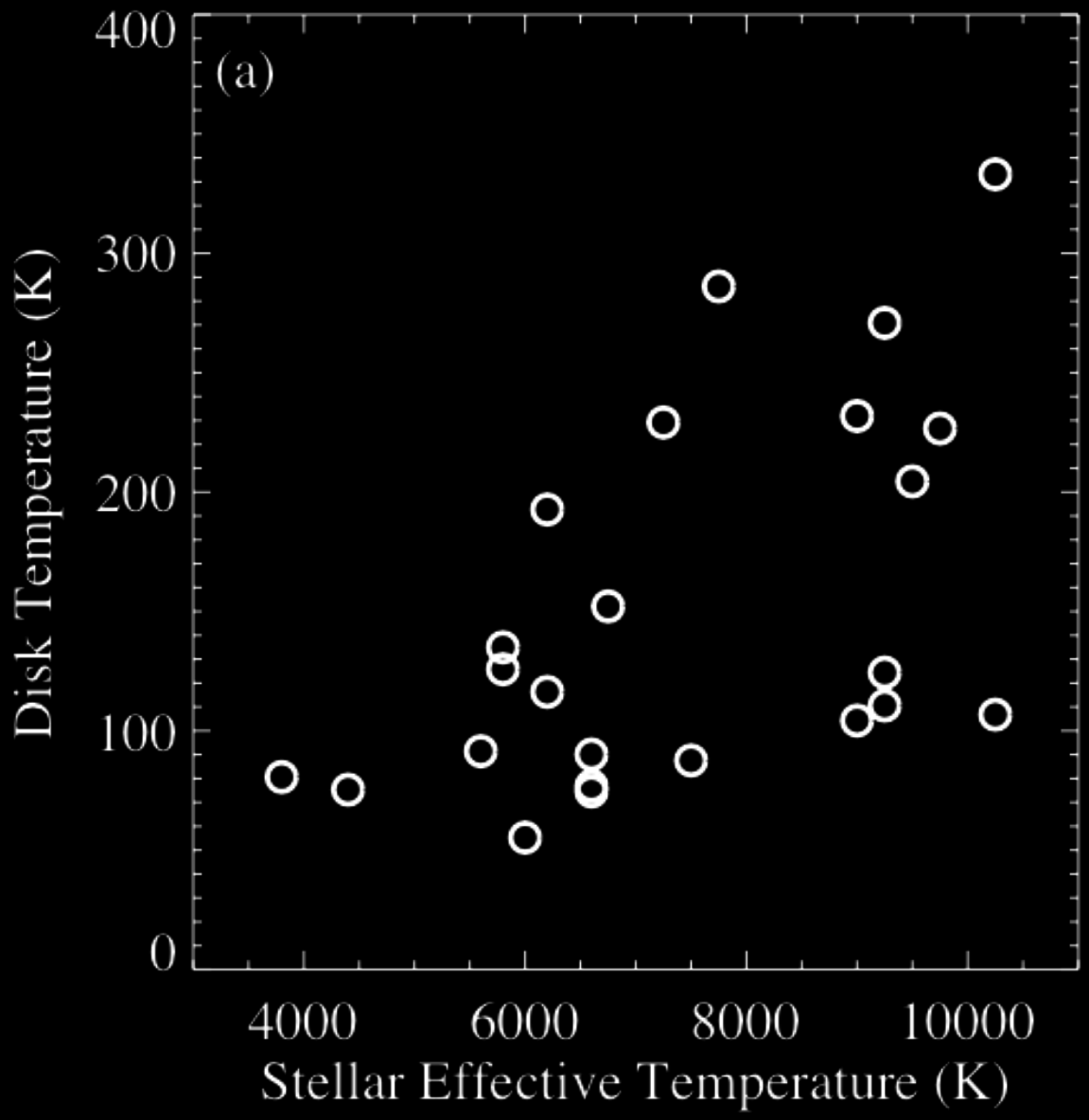
SED Fitting


HD181327
1.000
0.100
0.010
0.001
Flux (Jy)
10
100
1000
Wavelength (μm)
Stellar Atmosphere Models

SED Fitting

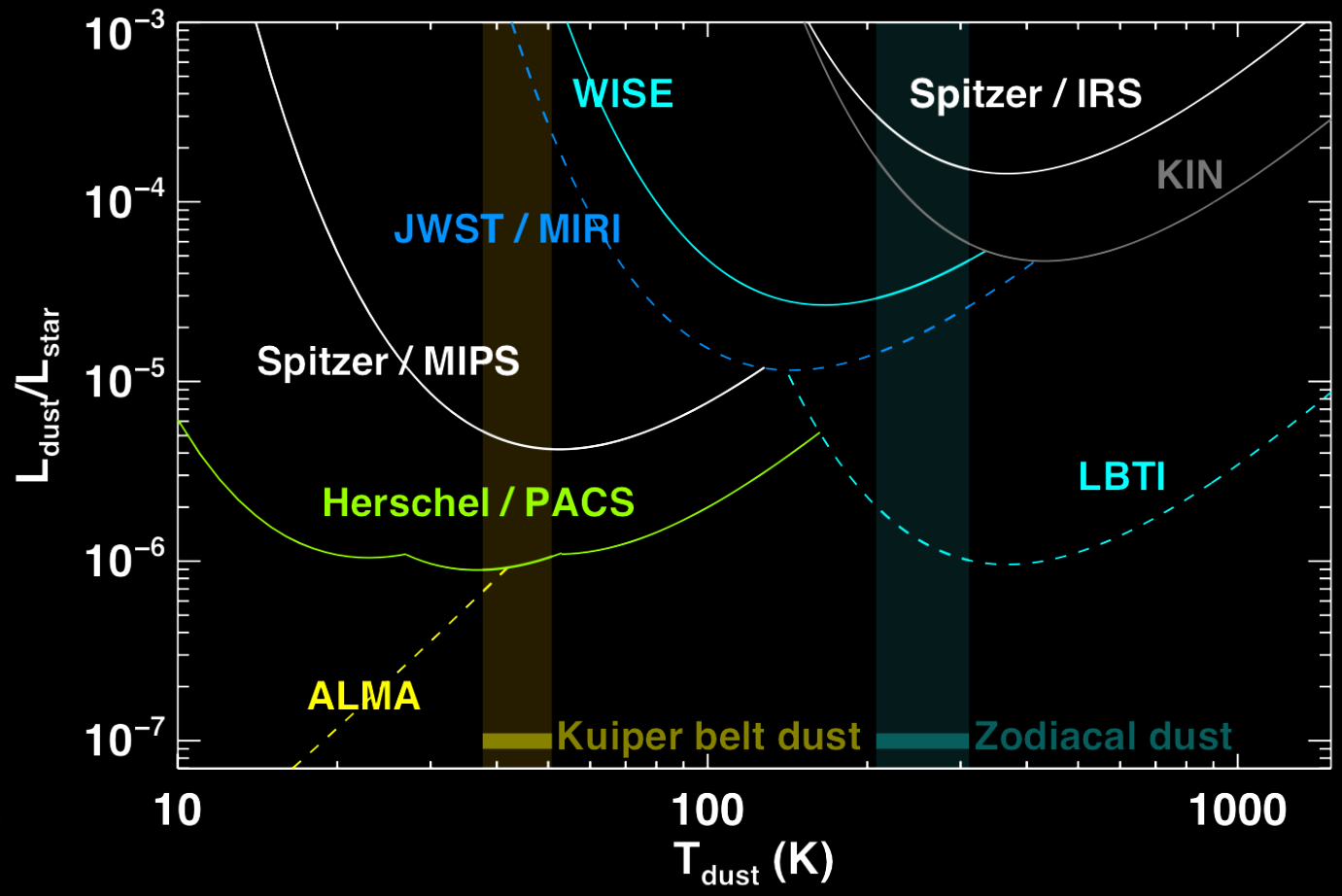

HD181327
1.000
0.100
0.010
0.001
Flux (Jy)
10
100
1000
Wavelength (μm)
Modified Blackbody


(a)
Disk Temperature (K)
Stellar Effective Temperature (K)
(b)
L_{IR}/L_{star}
Disk Temperature (K)
(c)
L_{IR}/L_{star}
Stellar Effective Temperature (K)
(d)
L_{IR}/L_{star}
Age (Myrs)


(a)
Disk Temperature (K)
400
300
200
100
0
4000
6000
8000
10000
Stellar Effective Temperature (K)

Is the deficit due to detection limit?

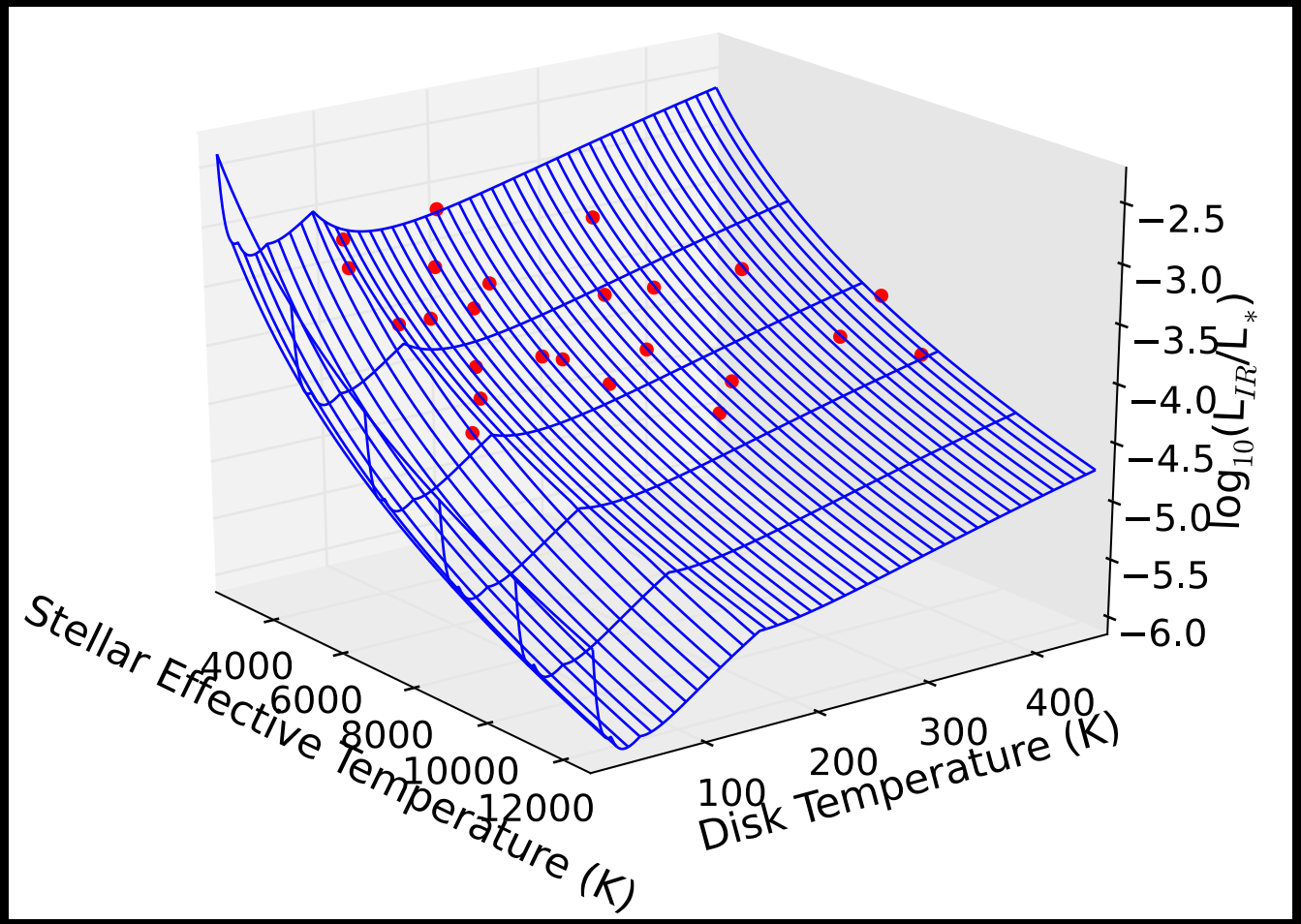
Relative Dust Luminosity (L_{IR}/L_*)



Dust Temperature (K)

Roberge et al. (2012)

We should be able to detect disks in the empty region



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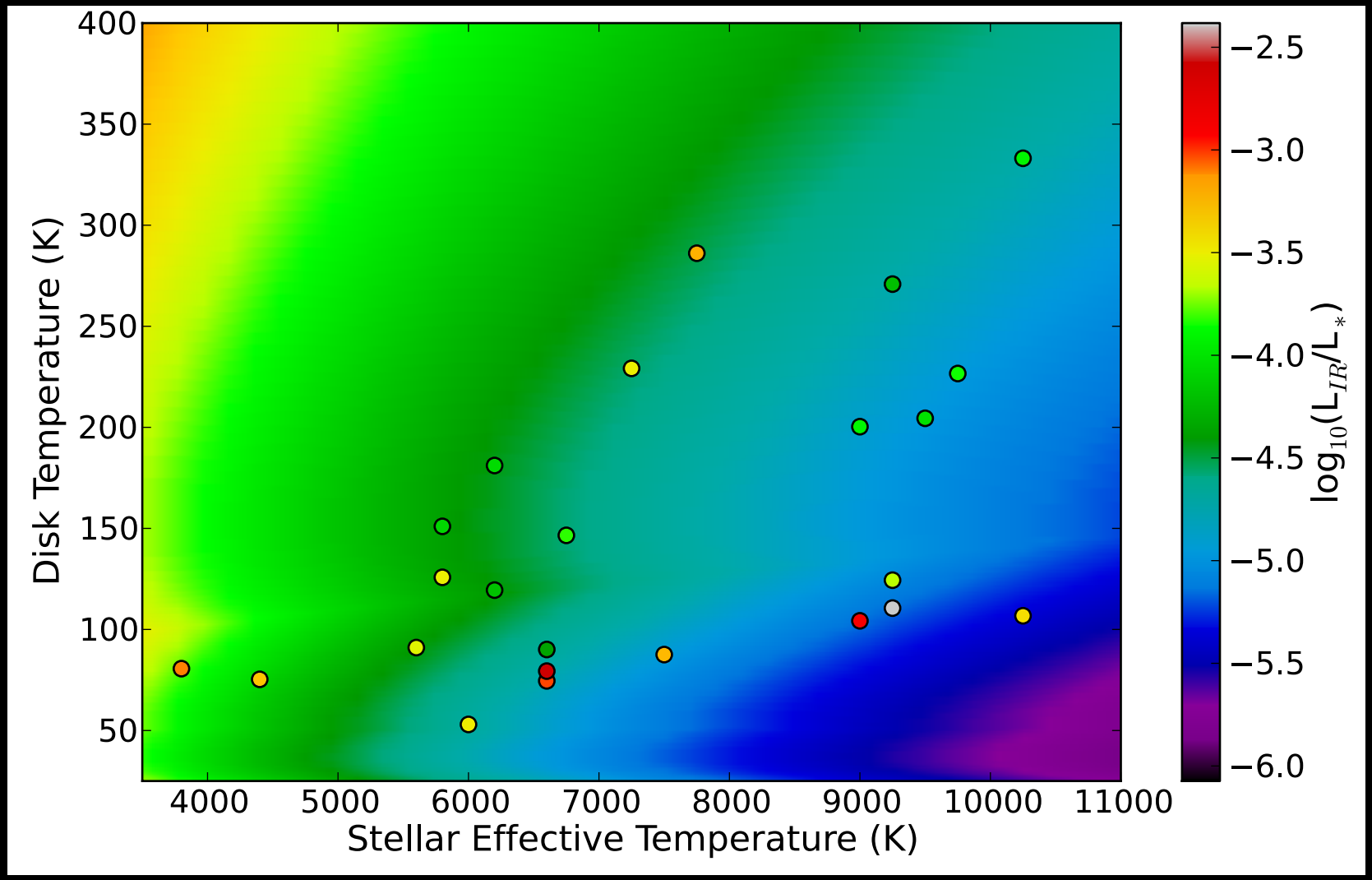
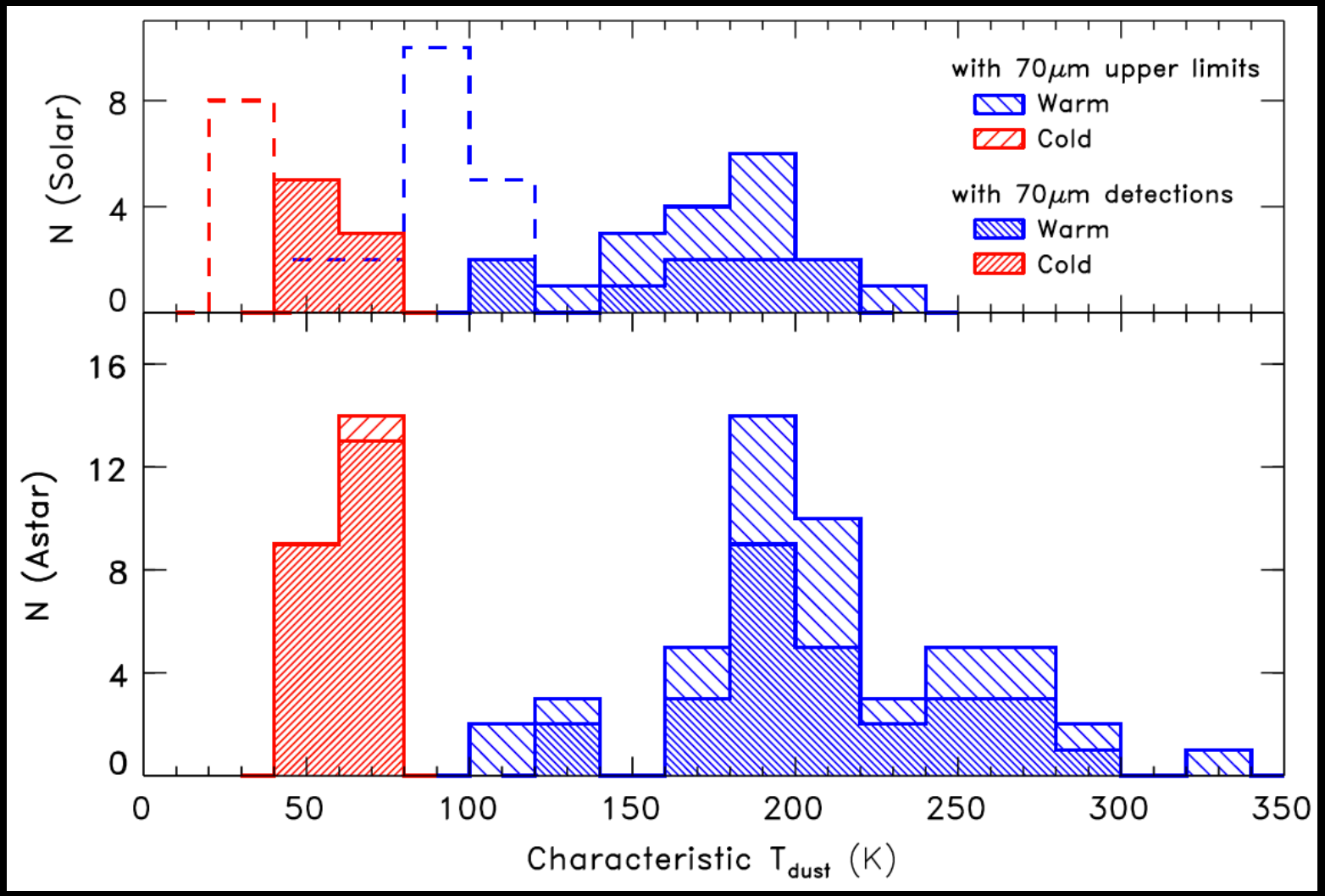
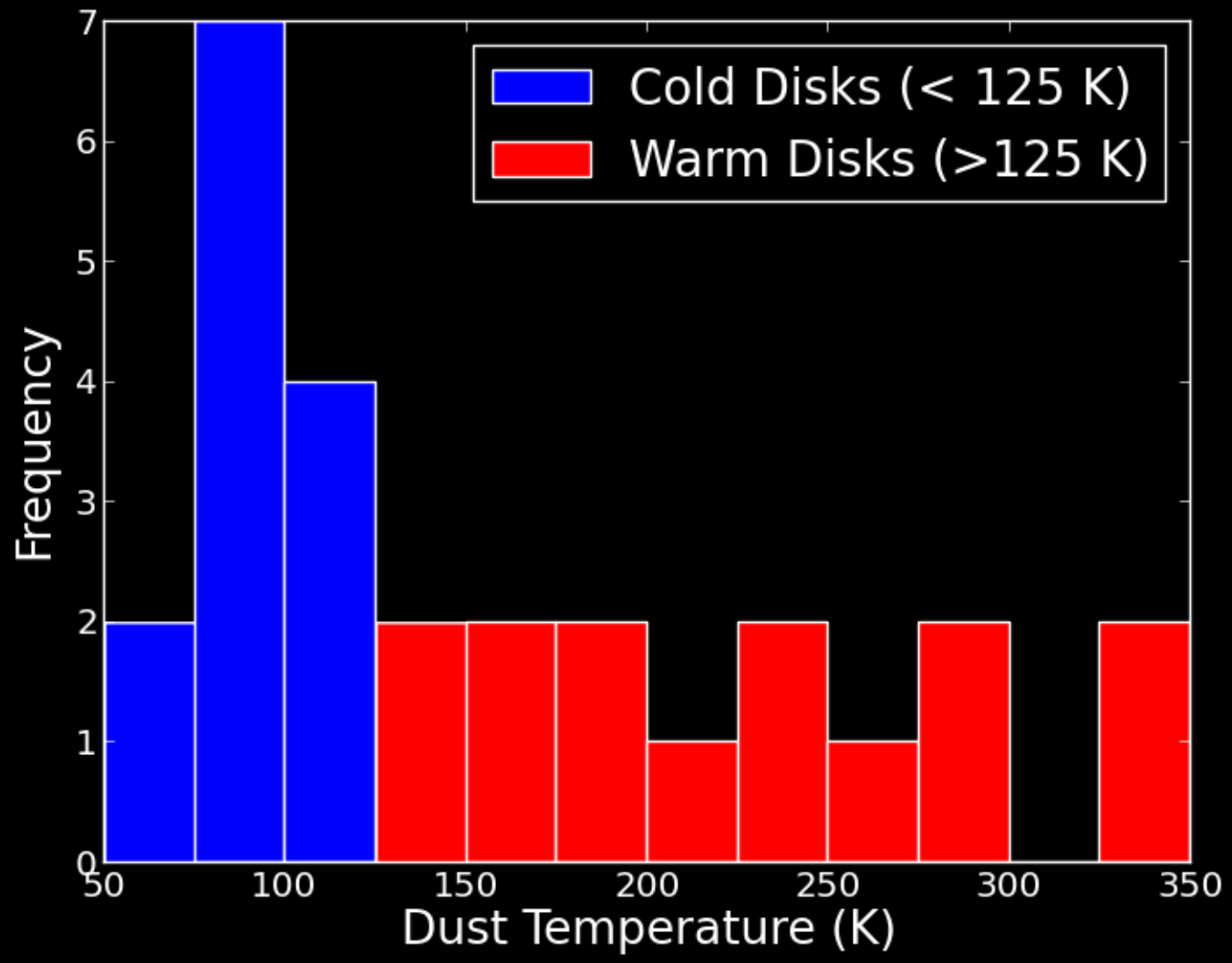


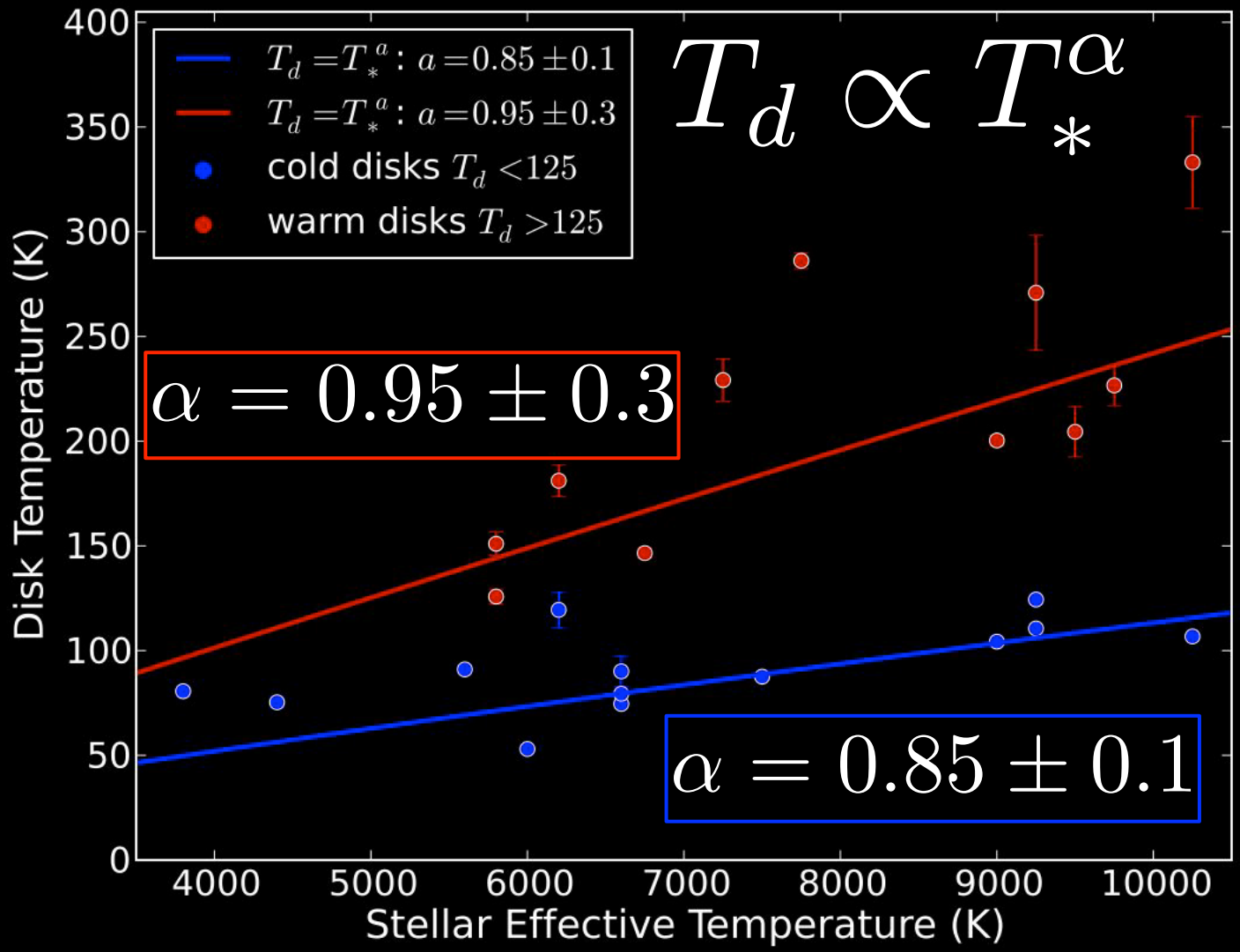
Morales et al. (2011) –all warm disks have similar temperatures



We split the disks into warm and cold populations



Power-law temperature trend

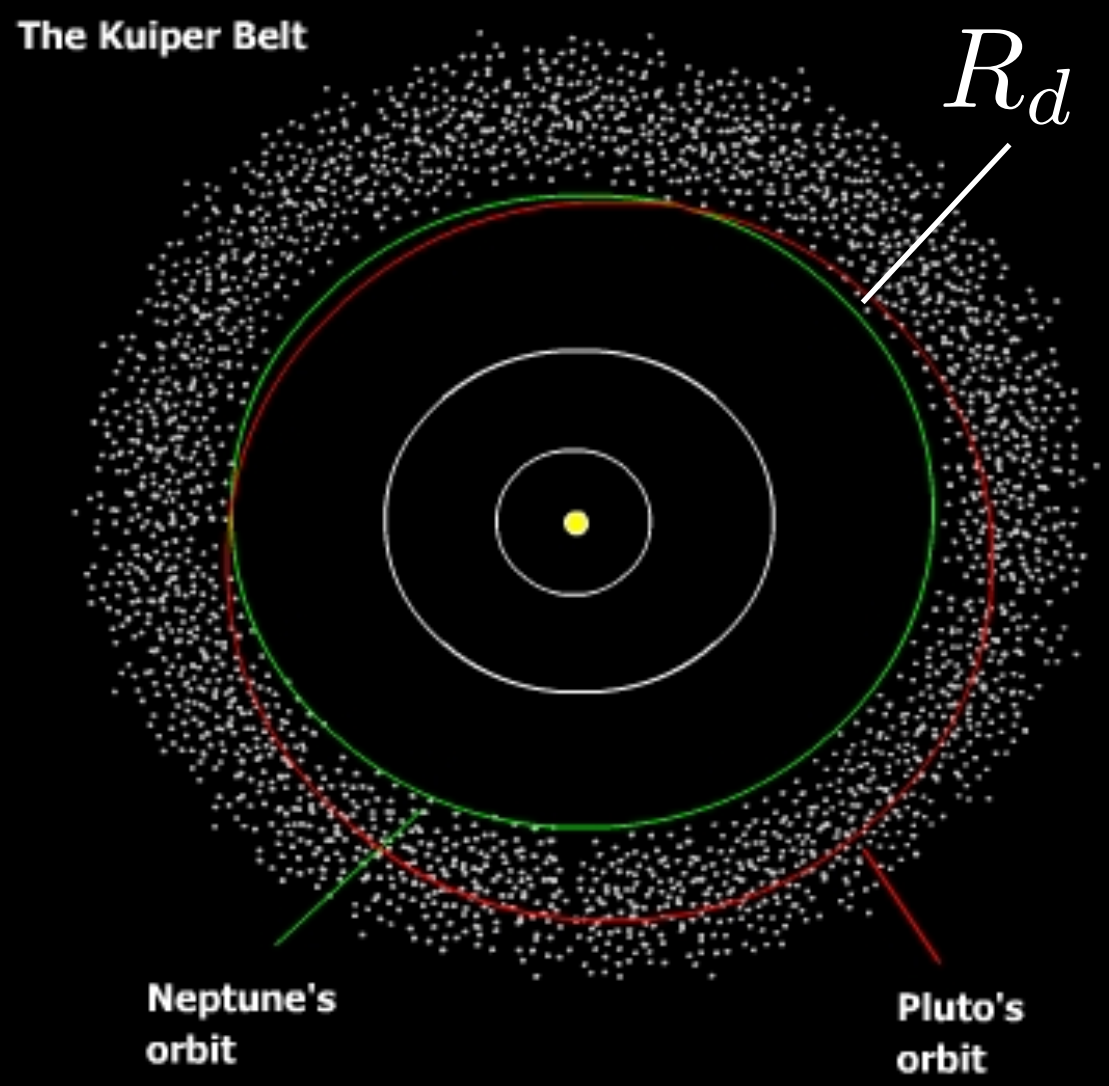


Interpretation of temperature trend

- Constant Temperature $T_d = const,\ \alpha = 0$
- Constant Radius $T_d \propto T_*^{7/4}$
- Disk Radius vs Stellar Mass relations

$$R_d \propto M_*^{\gamma},\ \gamma \sim 0.9$$

Interpretation of temperature trend



$$R_d \propto \sqrt{M_*}$$

Conclusions

- Surveyed 68 stars in 4 stellar associations
  - Found 24 debris disks
- Fit the disks with modified blackbody models
- Found a trend between disk and stellar tempertaure
  - Remnant of planet formation?