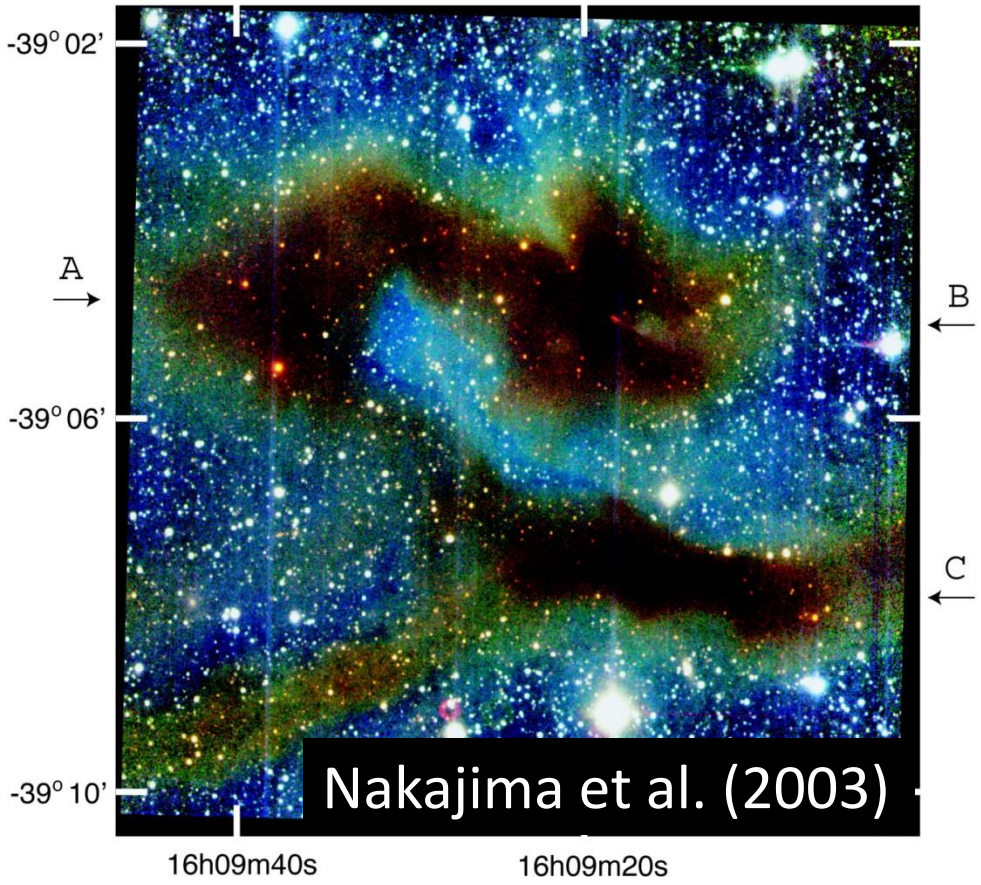
Near-Infrared Color of Molecular Clouds

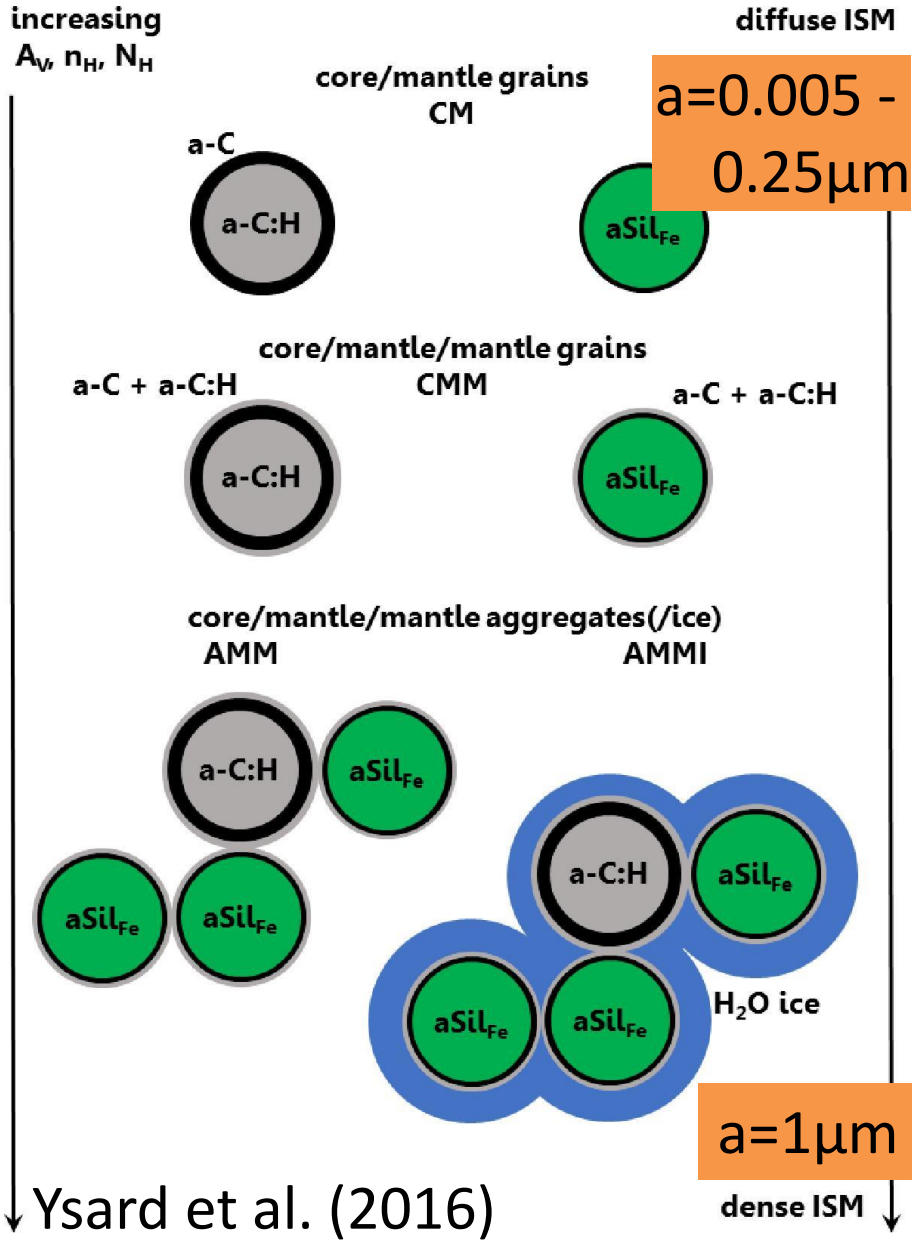
Yoichi Itoh

(University of Hyogo)

1. Dust growth in a molecular cloud ?

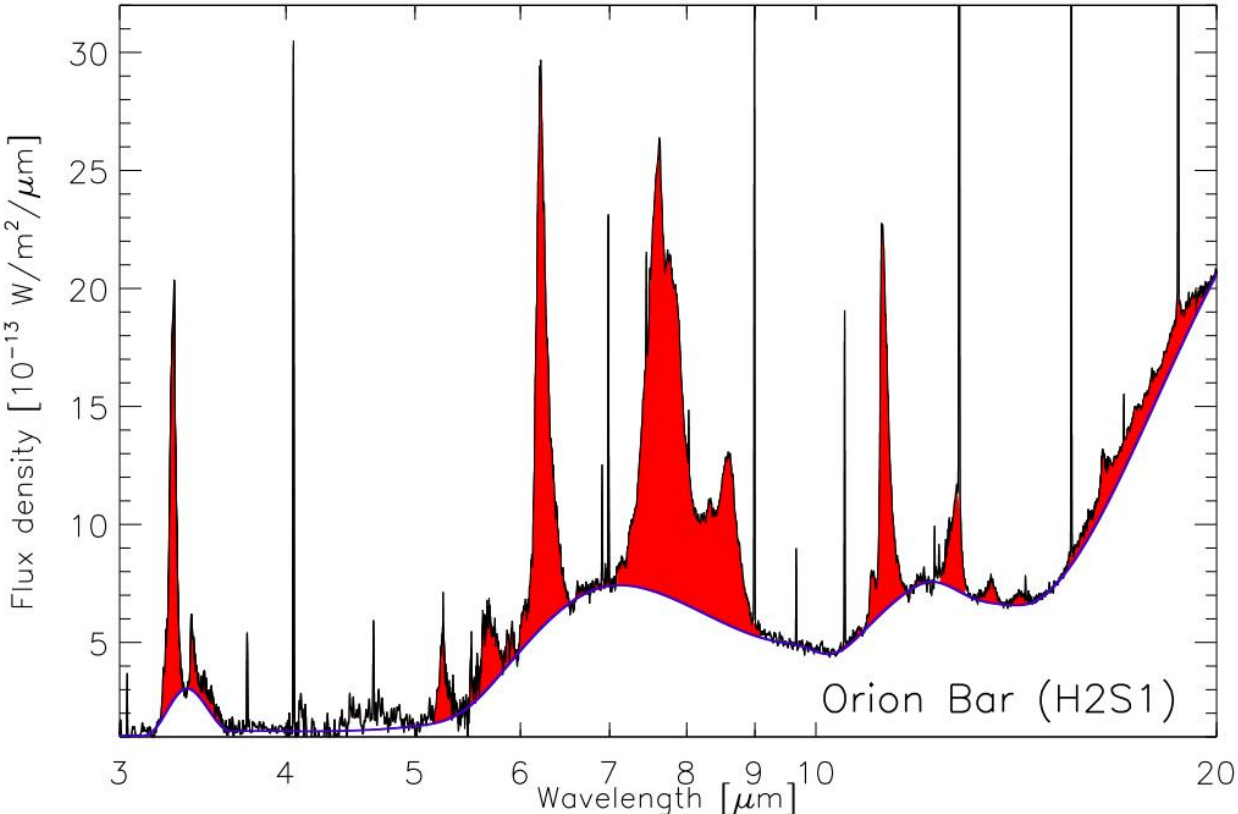
Cloudshine: Clouds emit in NIR
implication of dust growth ?





2. PAH(Poly-cyclic Aromatic Hydrocarbon)

- Many emissions in IR. Molecular bands are broad.
  → Effective coolant of a cloud.
- Strong emission in PDR (E>11.18eV)
- Strengths of the PAH features are function of the number of molecules, degree of ionization, strength of UV radiation.



IR spectrum of Orion bright bar. Red: PAH emissions

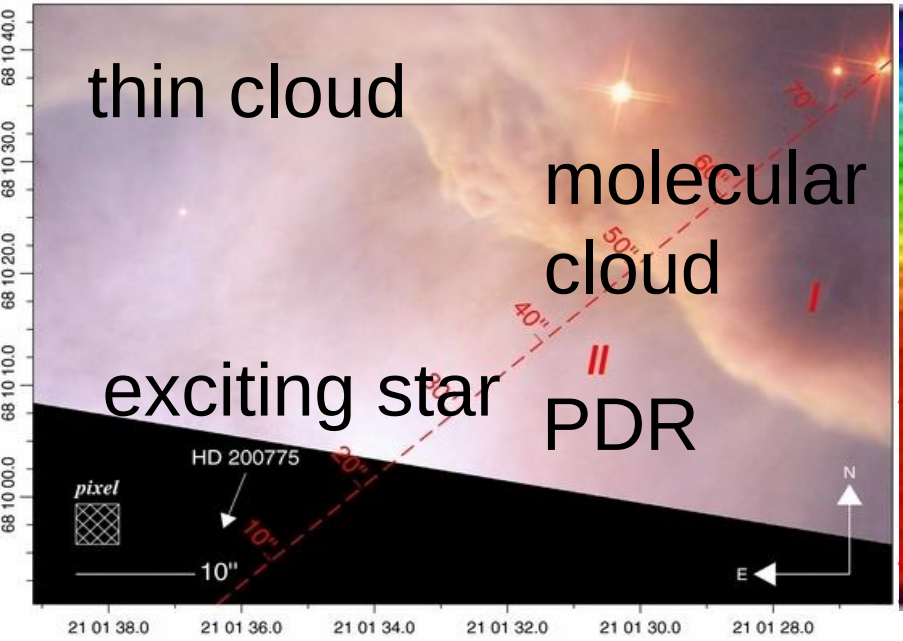
Spatial distribution of PAH emission is not fully investigated.

3. Spatial distribution of dusts

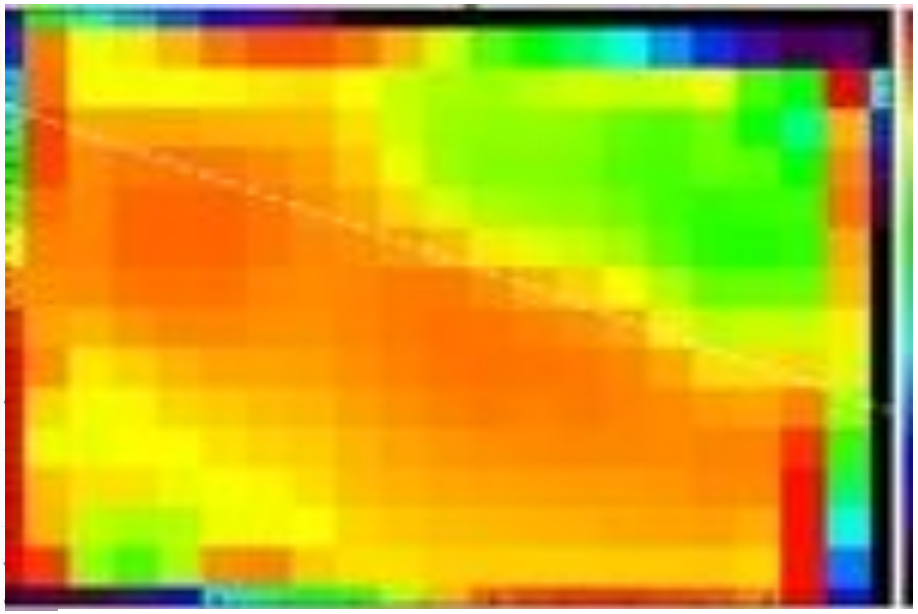
Boersma et al. (2013)

- NGC7023(PDR), Spitzer/IRS 5.2 - 14.5 μm scan mode
- Model fitting of PAH emissions
- 「Large dusts in PDR」

Large dust: The number of carbon atom: 50 -- 328



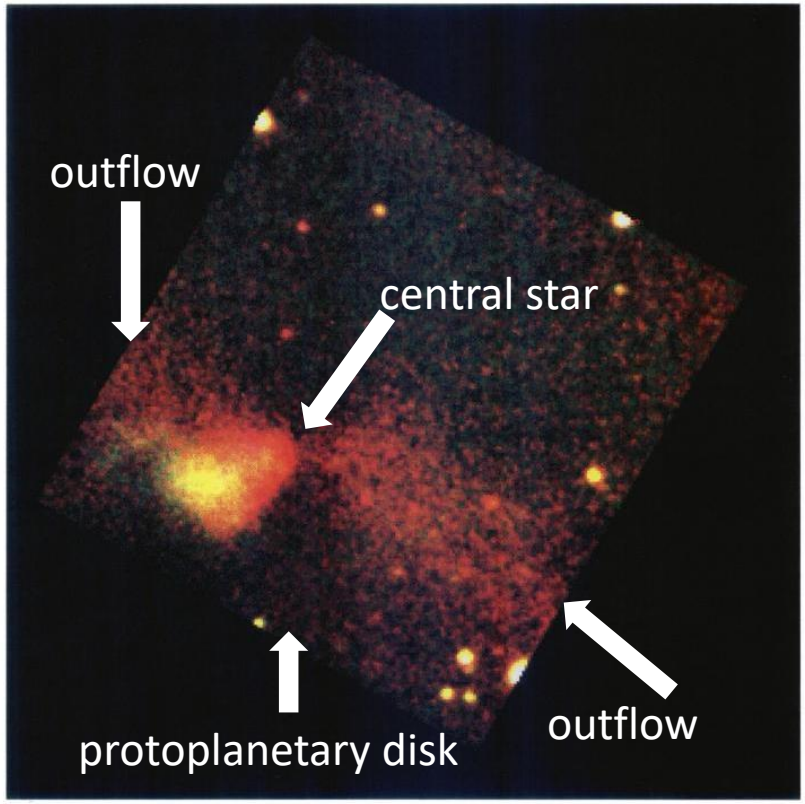
HST optical image of NGC7023



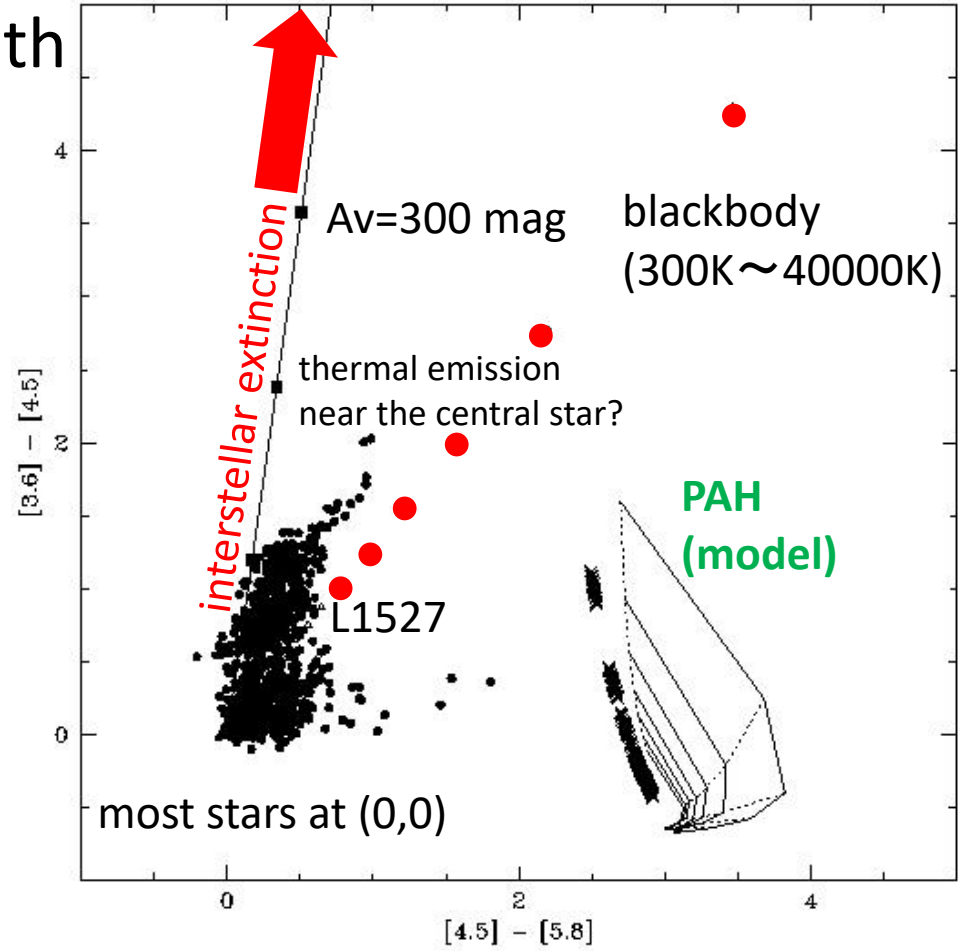
Fraction of large dusts deduced from PAH emissions

4. IR color of a protostar L1527

- investigate nebula color with Spitzer/IRAC archival data.
- Spatial resolution: 2.0”



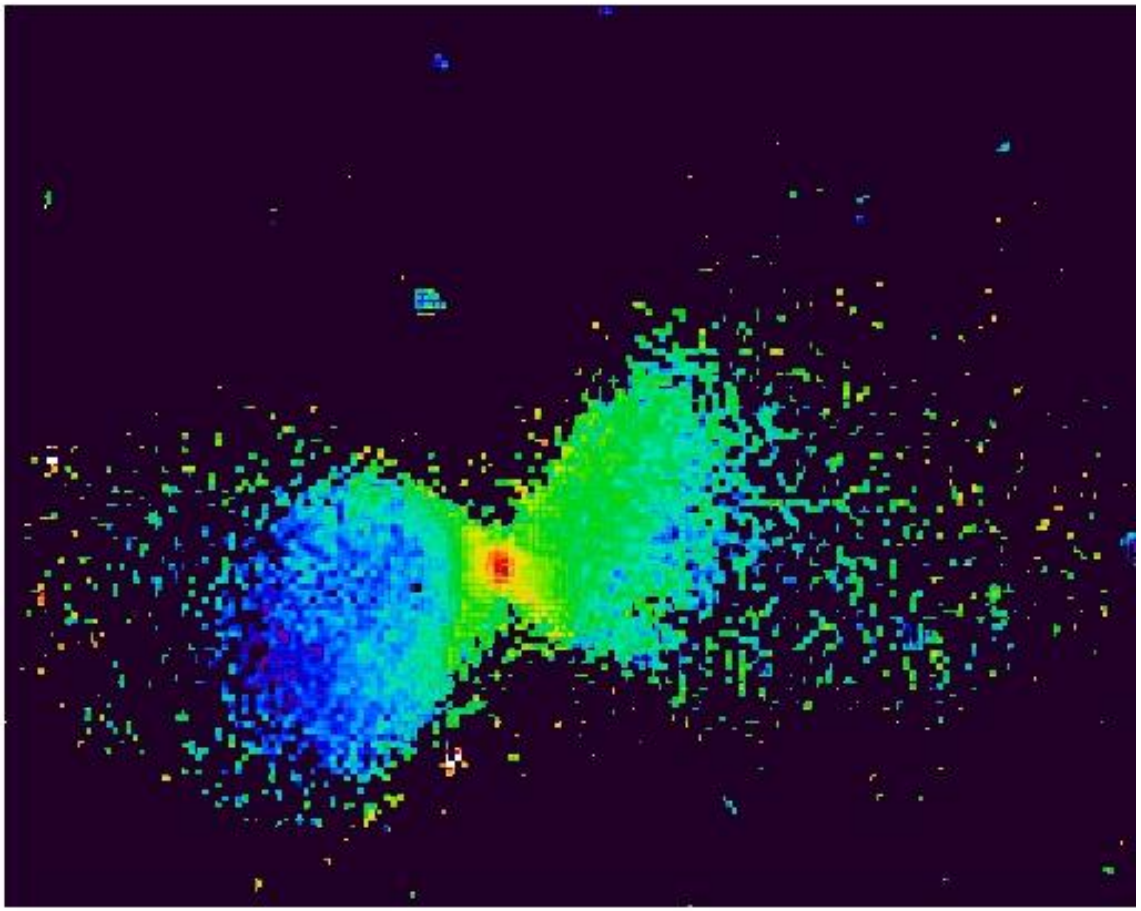
NIR 3 color image of L1527



- Central star of L1527 is low-mass star.
- No UV, PAH not excited.

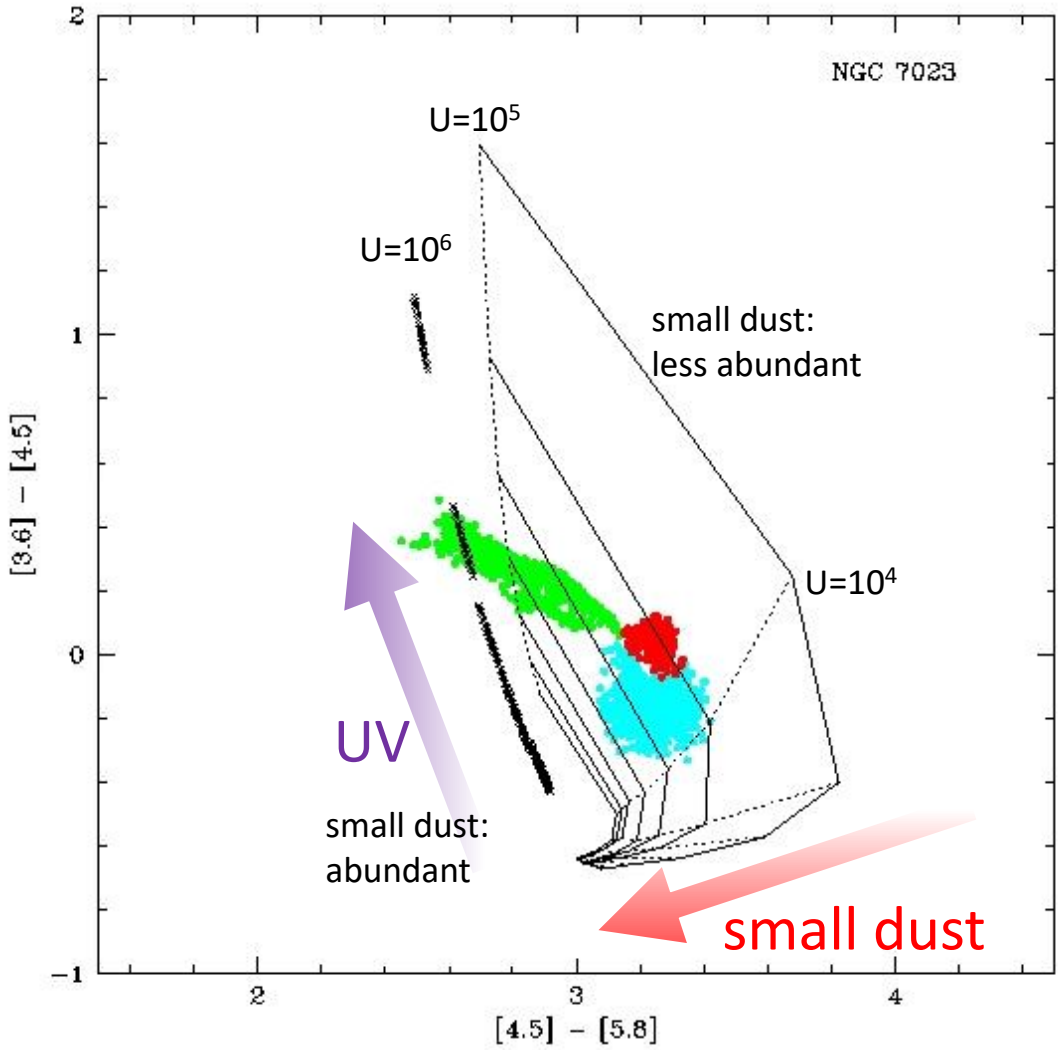
4. IR color of a protostar L1527

- large extinction near the central star.
- Av = 100 mag or more at the center.



Extinction map of L1527 nebula. Blue: small, red: large

5. IR color of NGC7023(PDR)



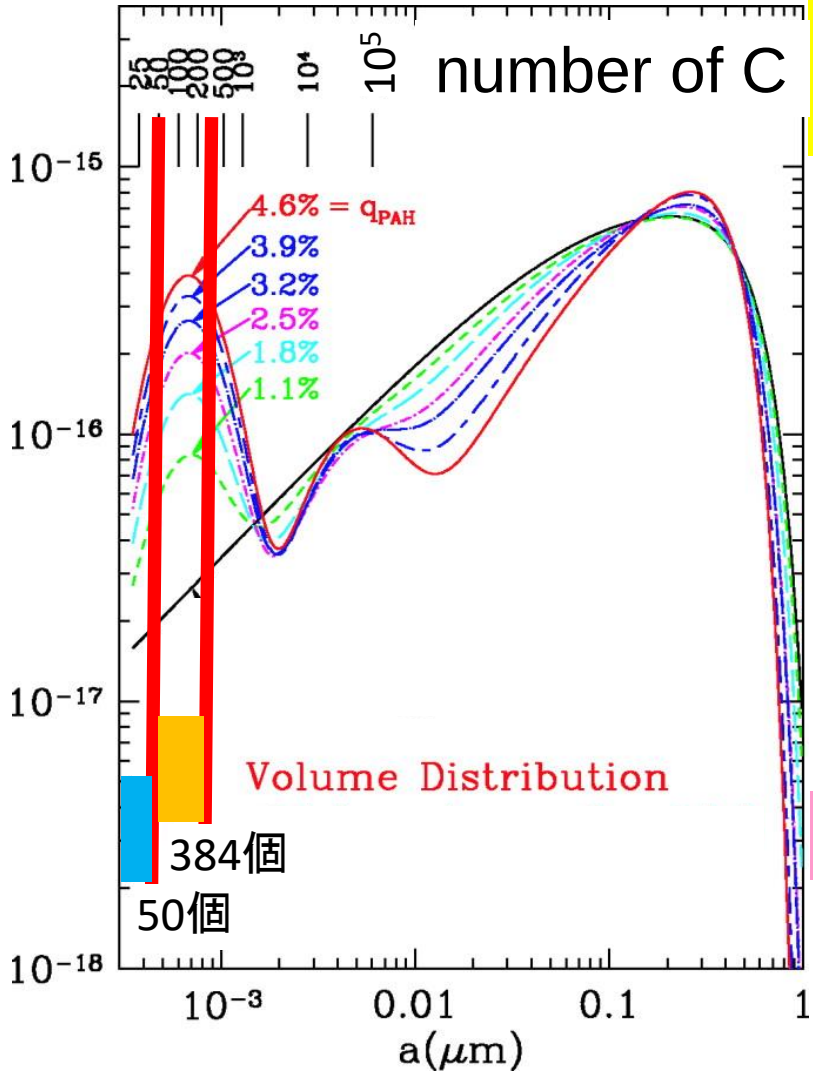
molecular cloud
- weak UV
- small dust: poor

thin cloud
- weak UV
- small dust: rich

PDR
- strong UV
- small dust: rich

Nebula color of NGC7023
Solid line: dust radius, Dotted line: UV radiation

5. IR color of NGC7023(PDR)



ダスト存在度 (Drainモデル)

Boersma+:large dusts in PDR
this study: small dusts in PDR

Dusts in Boersma et al. (2013)

small dust : number of C < 50

large dust : 50 < number of C < 384

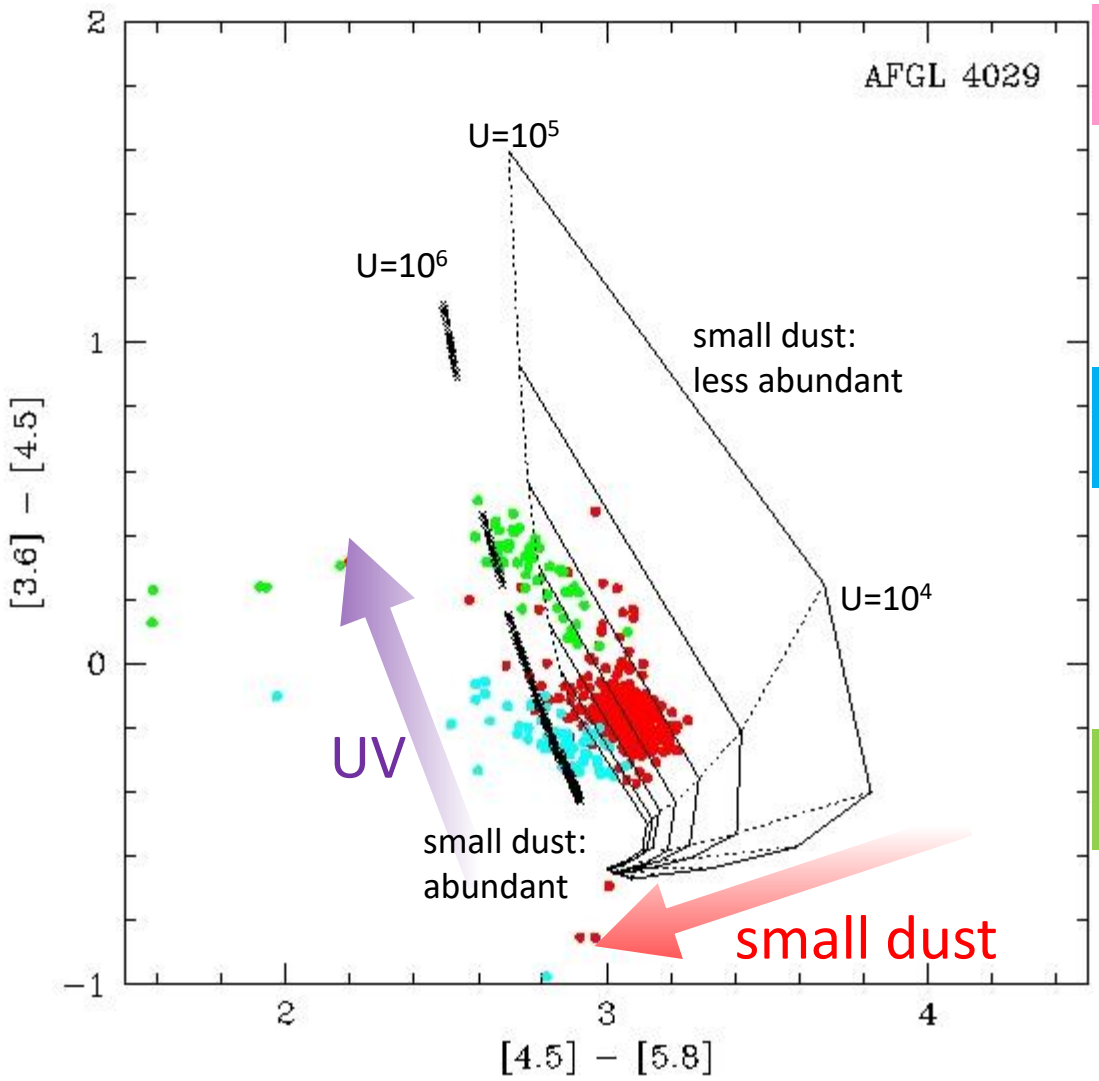
We used dust distribution of Draine, Li (2007). Small dusts in this study include large dusts of Boersma et al. (2013).

No conflicts in these two studies.

Different dust models in different paper.

→ Construct own dust model…

6. IR color of BRC13, 14



molecular cloud

- weak UV
- small dust: poor

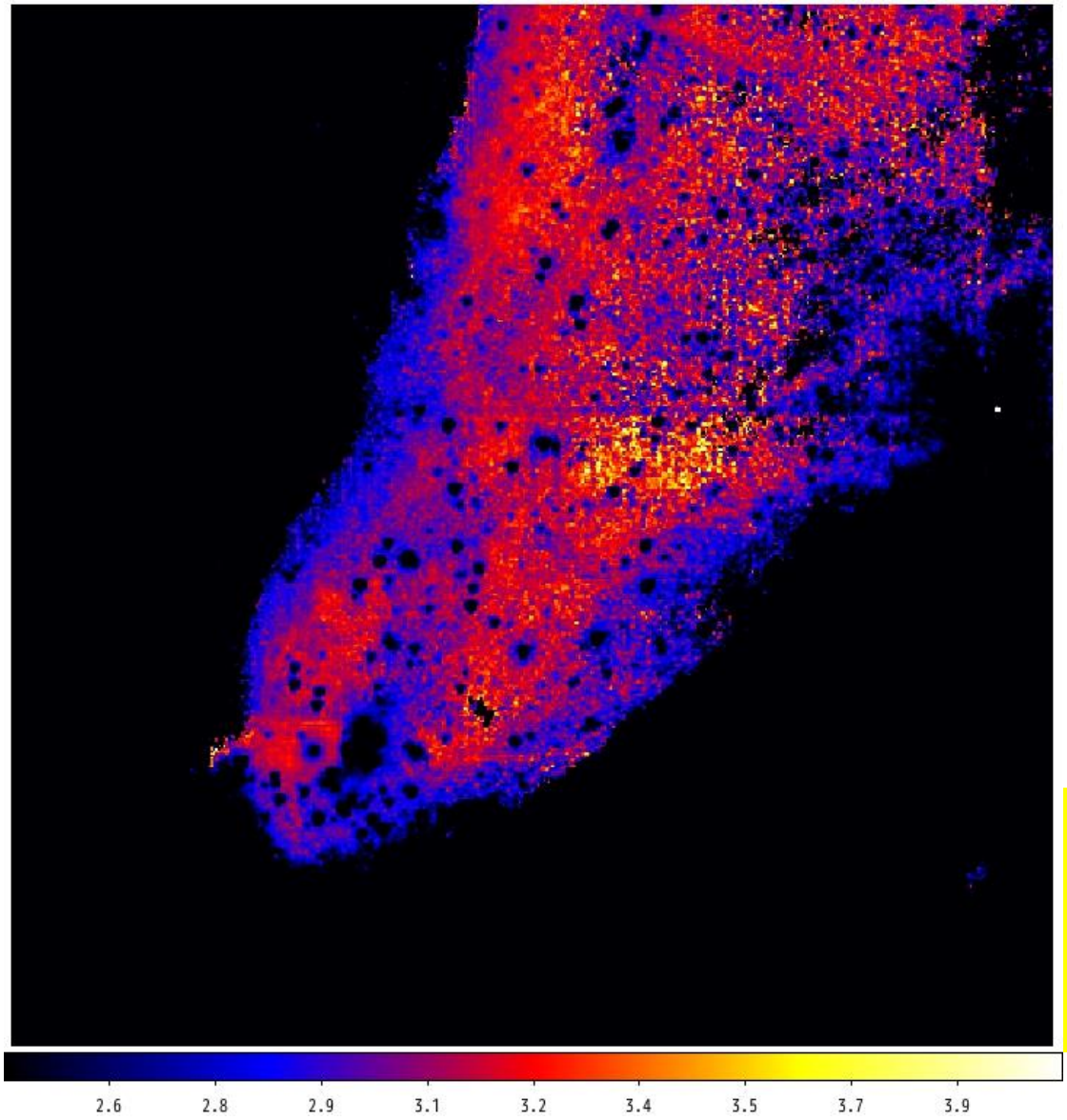
B-type BRC

- strong UV
- small dust: rich

Unusual region

- strong UV
- small dust: poor

6. IR color of BRC13, 14



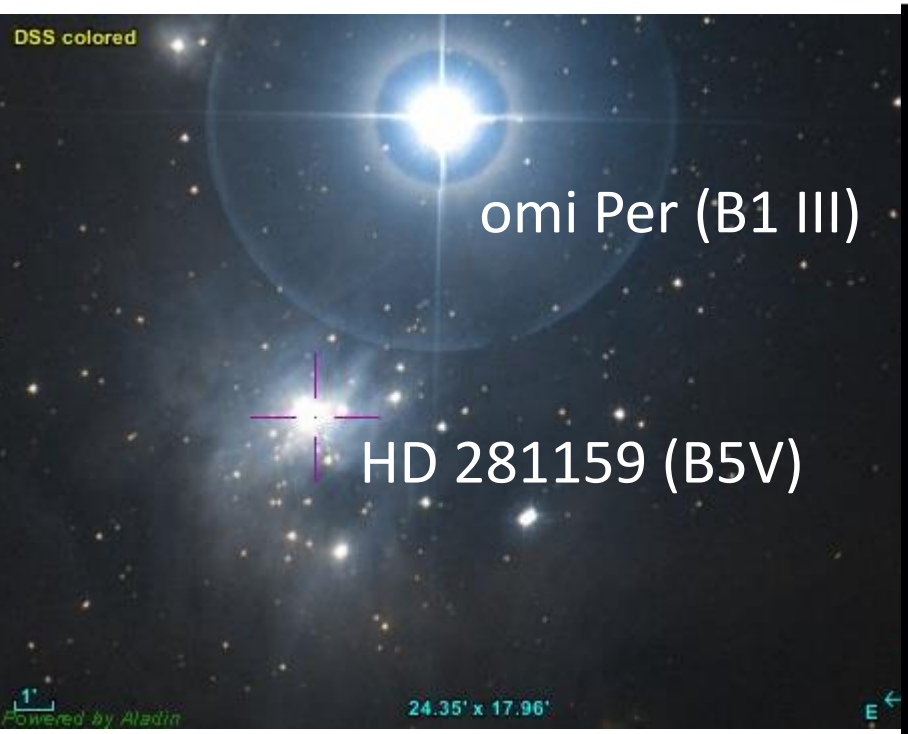
4.5μm - 5.8μm。Red: large color.

Large 4.5μm - 5.8μm color inside the cloud, indicating poor small dusts.

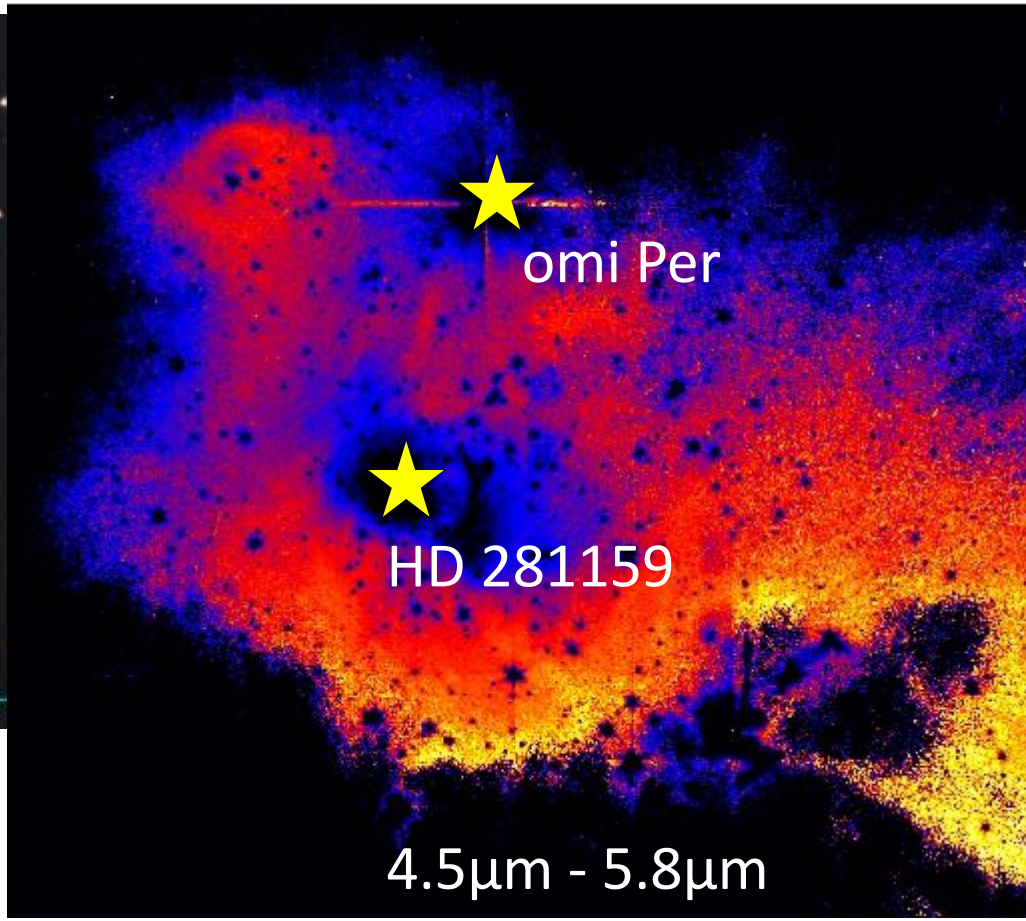
Small color at the edge of the cloud, indicating rich small dusts.

UV from the exciting star destroys dusts in the molecular cloud.

6. IR color of IC 348



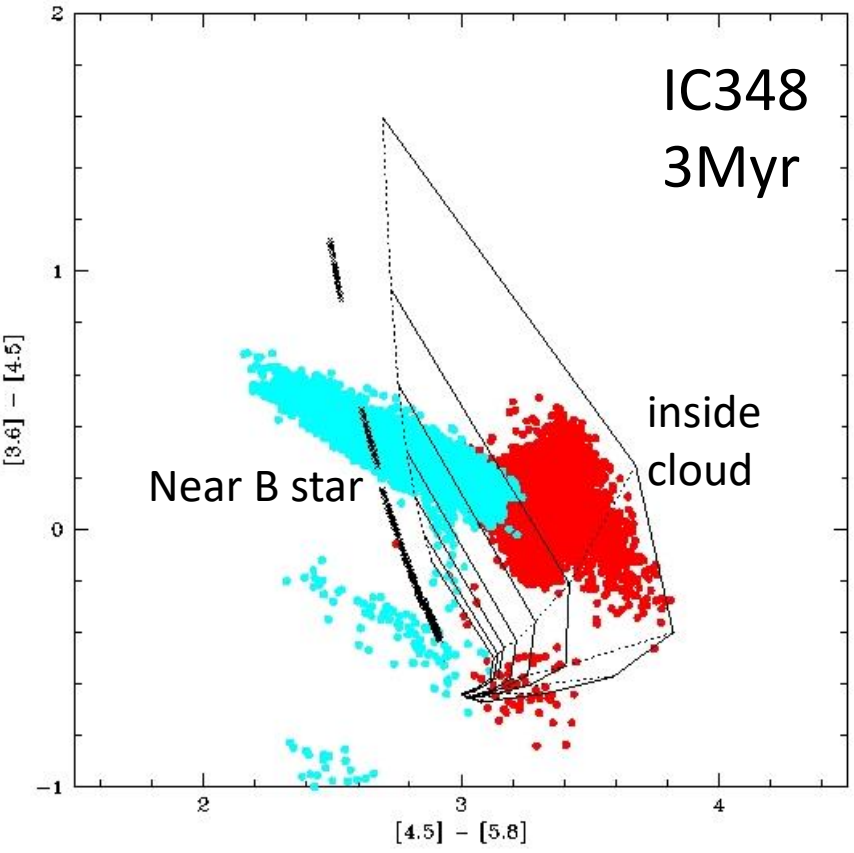
DSS optical image

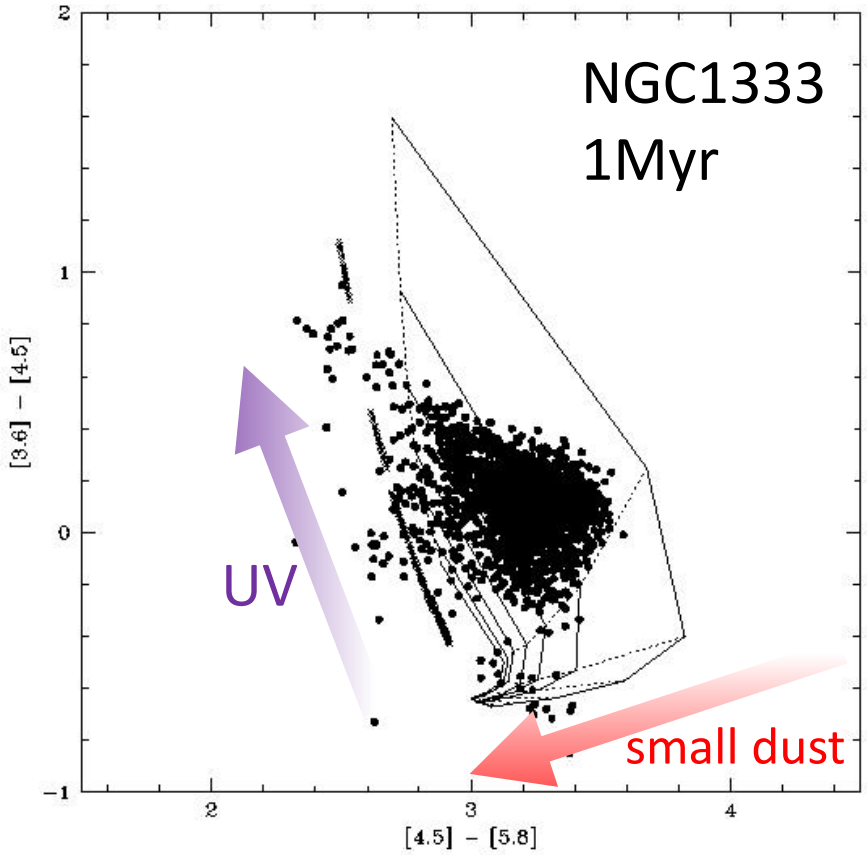


- Small color around a B-type star, indicating rich small dusts.
- UV from the B-type star destroys dusts

→ Dusts are large in a cloud unless destructed by UV.

6. IR color of IC 348



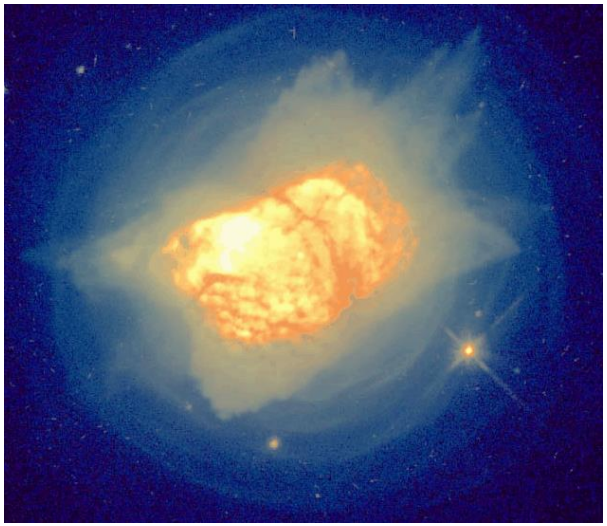


- Small dusts are poor in IC348 (old) than those in NGC 1333

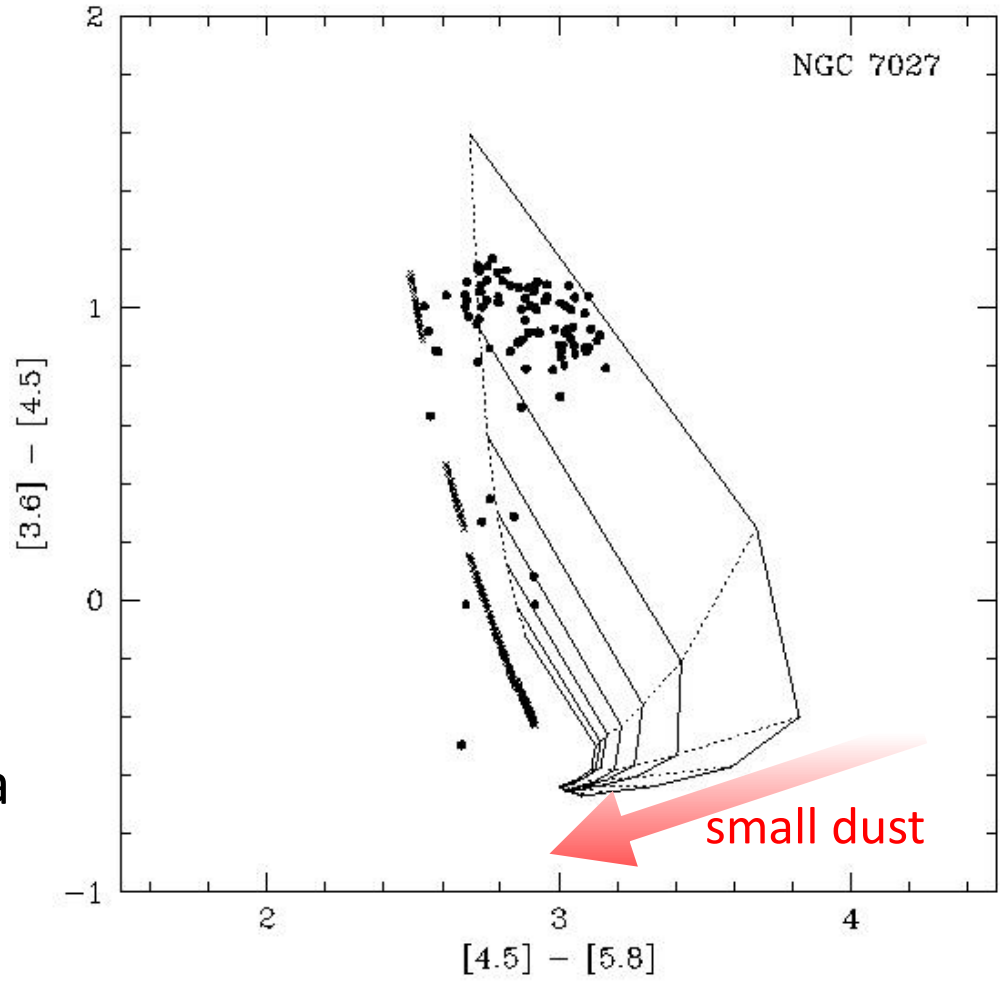
→ Dusts are coagulating inside a cloud ??

8. Dusts in a planetary nebula

Dusts are very small before cloud formation



NGC7027: very young PN.
age: 600 yr.
Mass of the central star is origina
3-4 solar mass



Poor small dusts even in a planetary nebula……