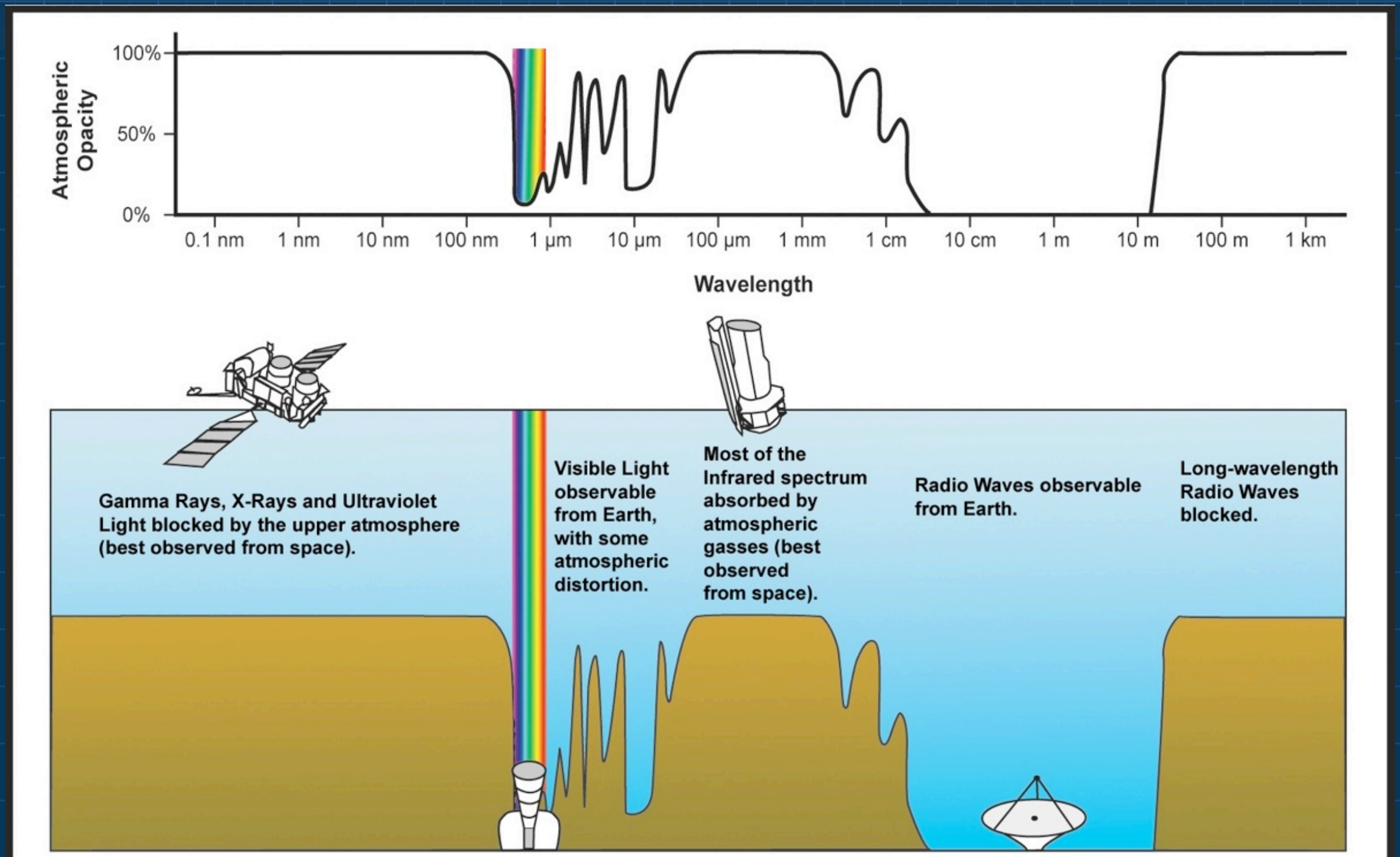
Physical Processes in Massive Star-Forming Regions

Recent observational progress with millimeter arrays

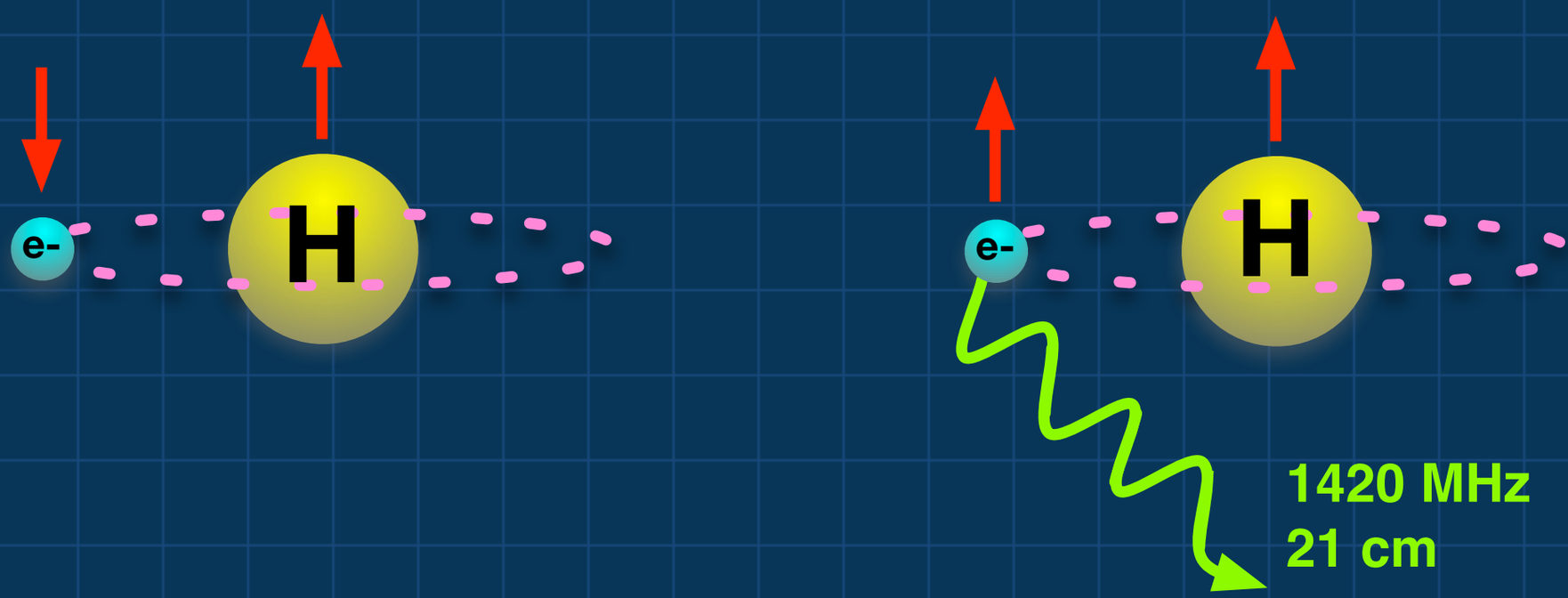
陳惠茹

September 20, 2006 (清大物理)

Why Longer Wavelengths?



Hydrogen 21cm Forbidden Line



- Hyperfine interaction (forbidden transition)
- A ~ 2.9 X 10^{-15} s^{-1}; Lifetime ~ 10^{7} years

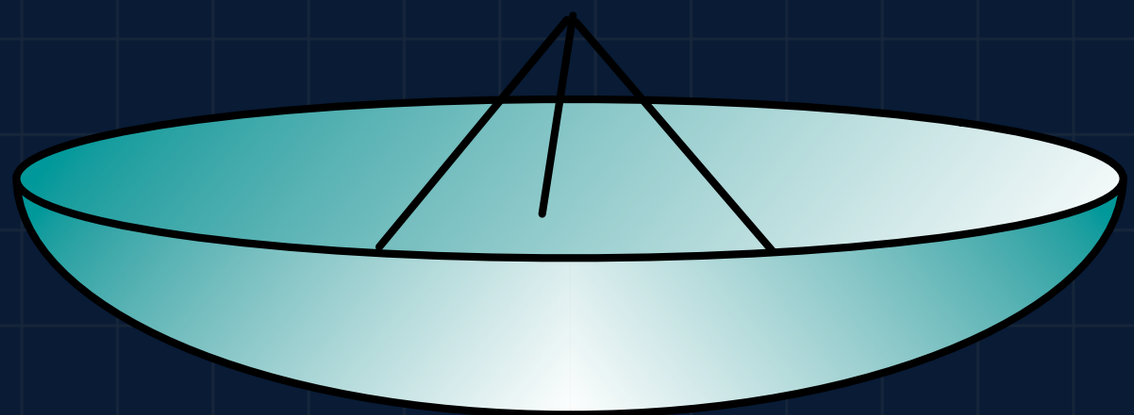
Molecular Clouds

- **Cold, dense molecular gas complex**
  - n ~ 10^3-10^6 cm^{-3}
  - T~ 10-50 K

Ophiuchus Giant Molecular Cloud (by Loke Tan)

What are arrays?

Angular resolution ~ 1.22 λ / D



What are arrays?

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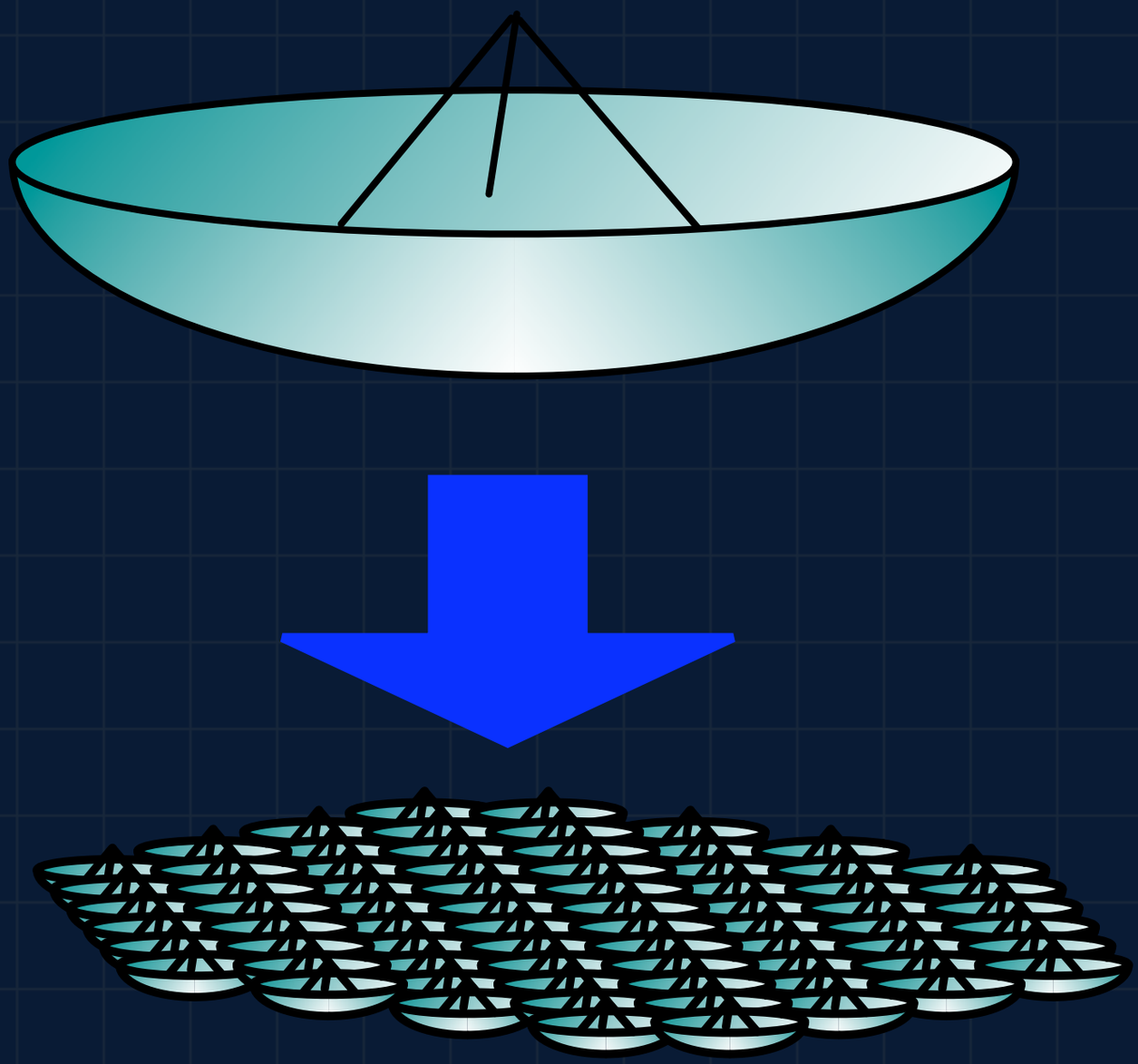
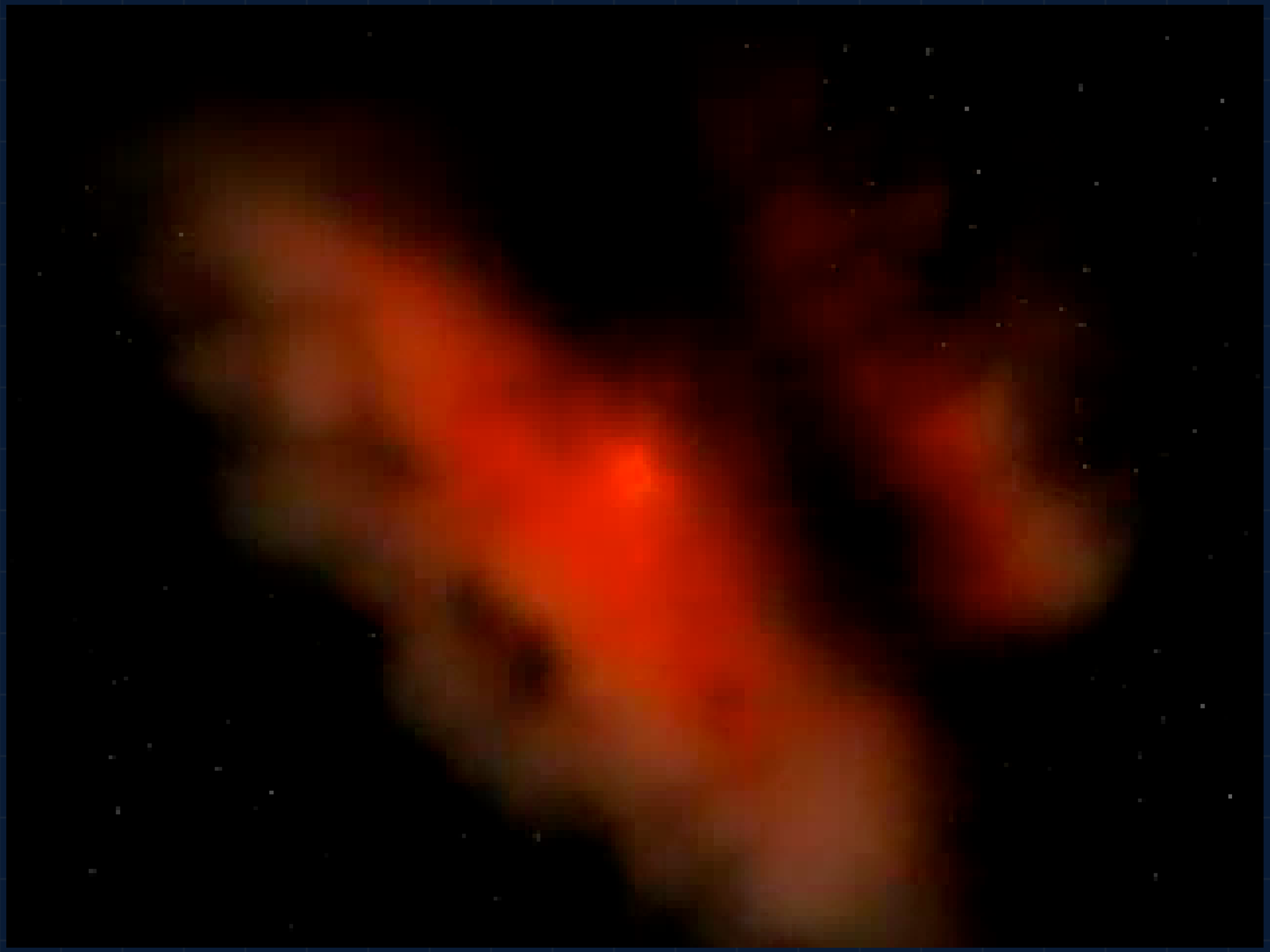


Millimeter and Submillimeter Arrays

How do stars form?

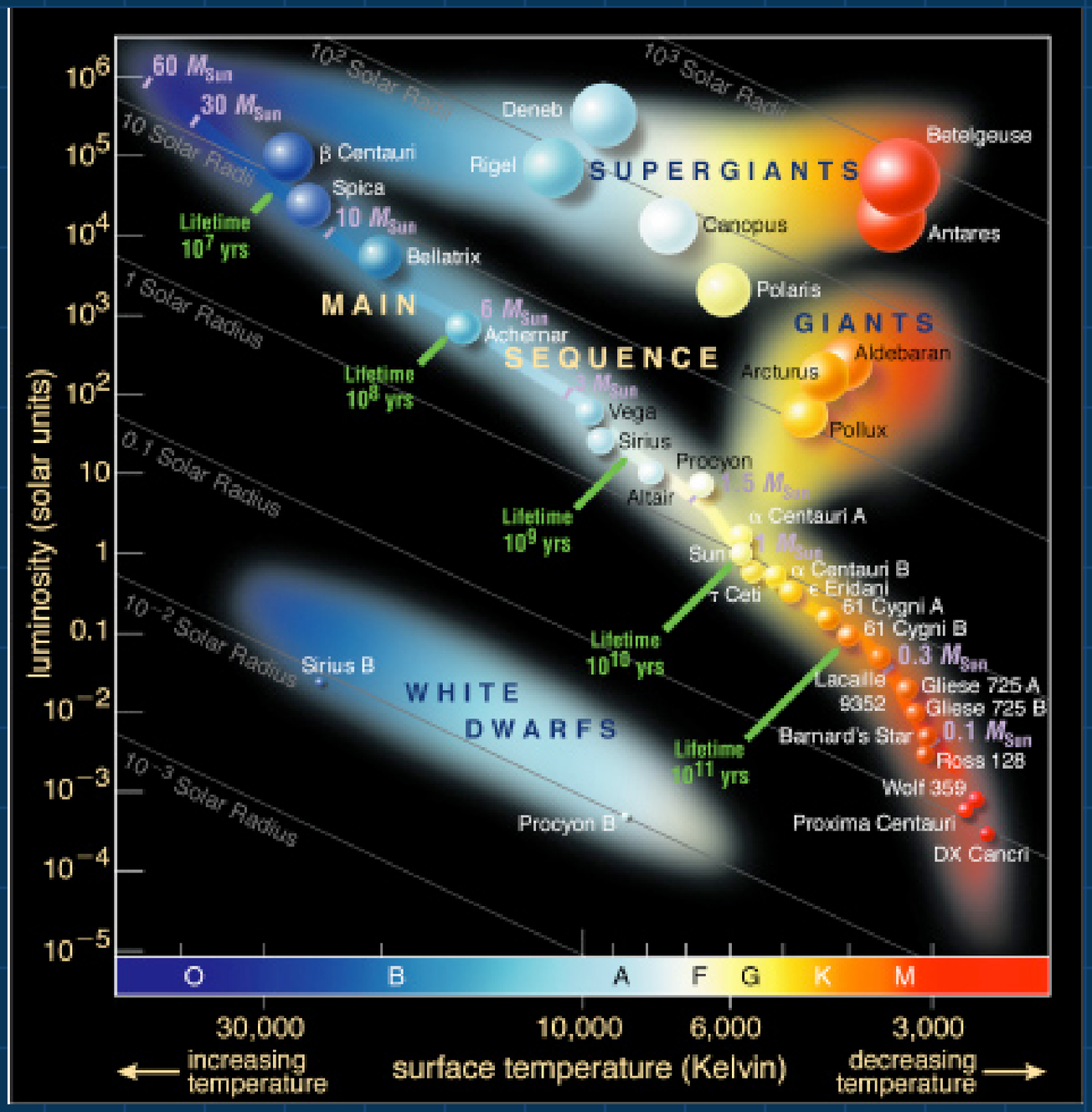
Low-Mass Protostars

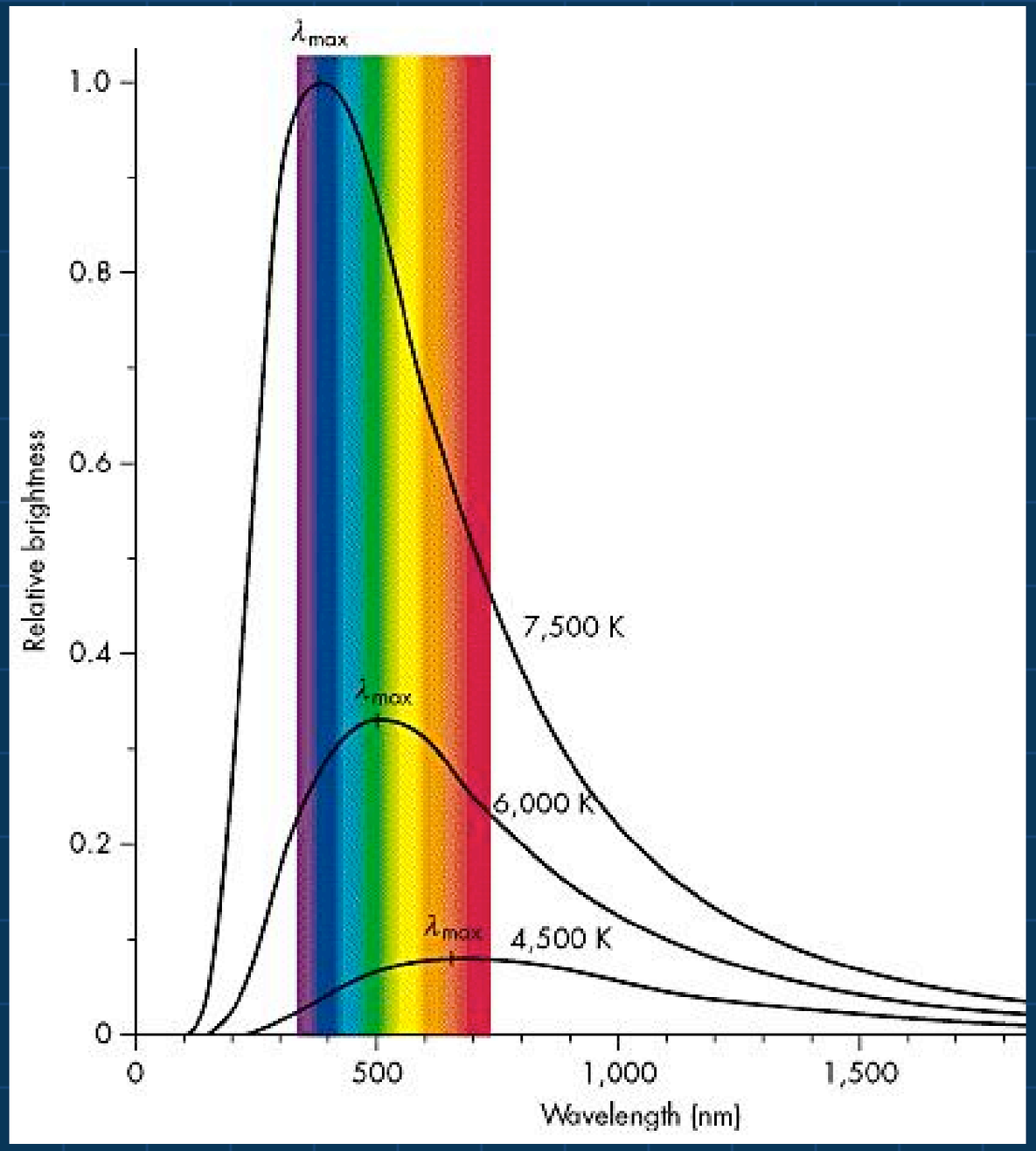


Credit:

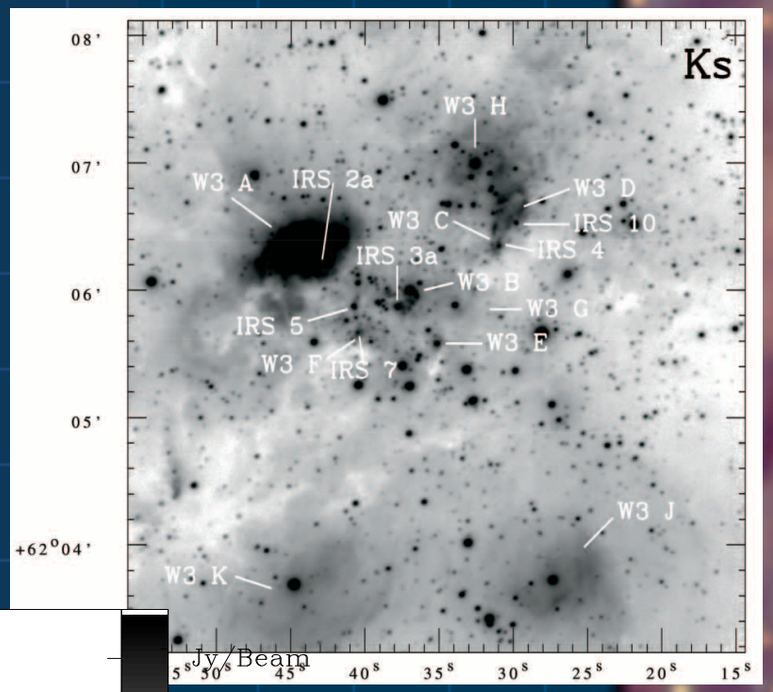
G. Bacon (STScI)

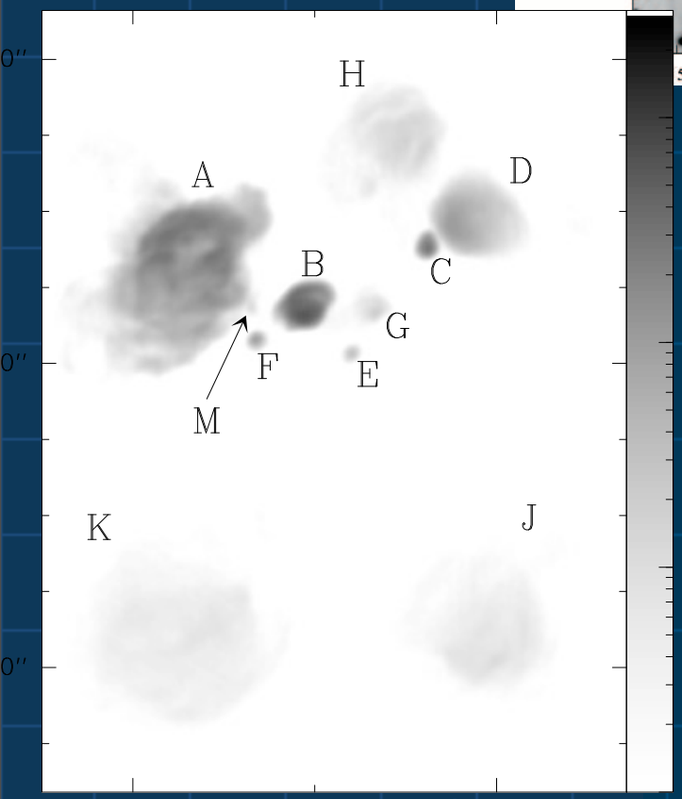
Massive Stars





Clustered Environment





Ojha et al. 2004

W3 Main

Observational test
Accretion vs Coalescence

- **Accretion or Infall**
  - Isolated, noninteracting cores
  - Collimated outflow
  - Stable IR

- Coalescence or Mergers
  - Clustered, interacting cores
  - Wide-angle outflow
  - Flaring in IR or radio

Bally & Zinnecker 2005

Massive Protostars

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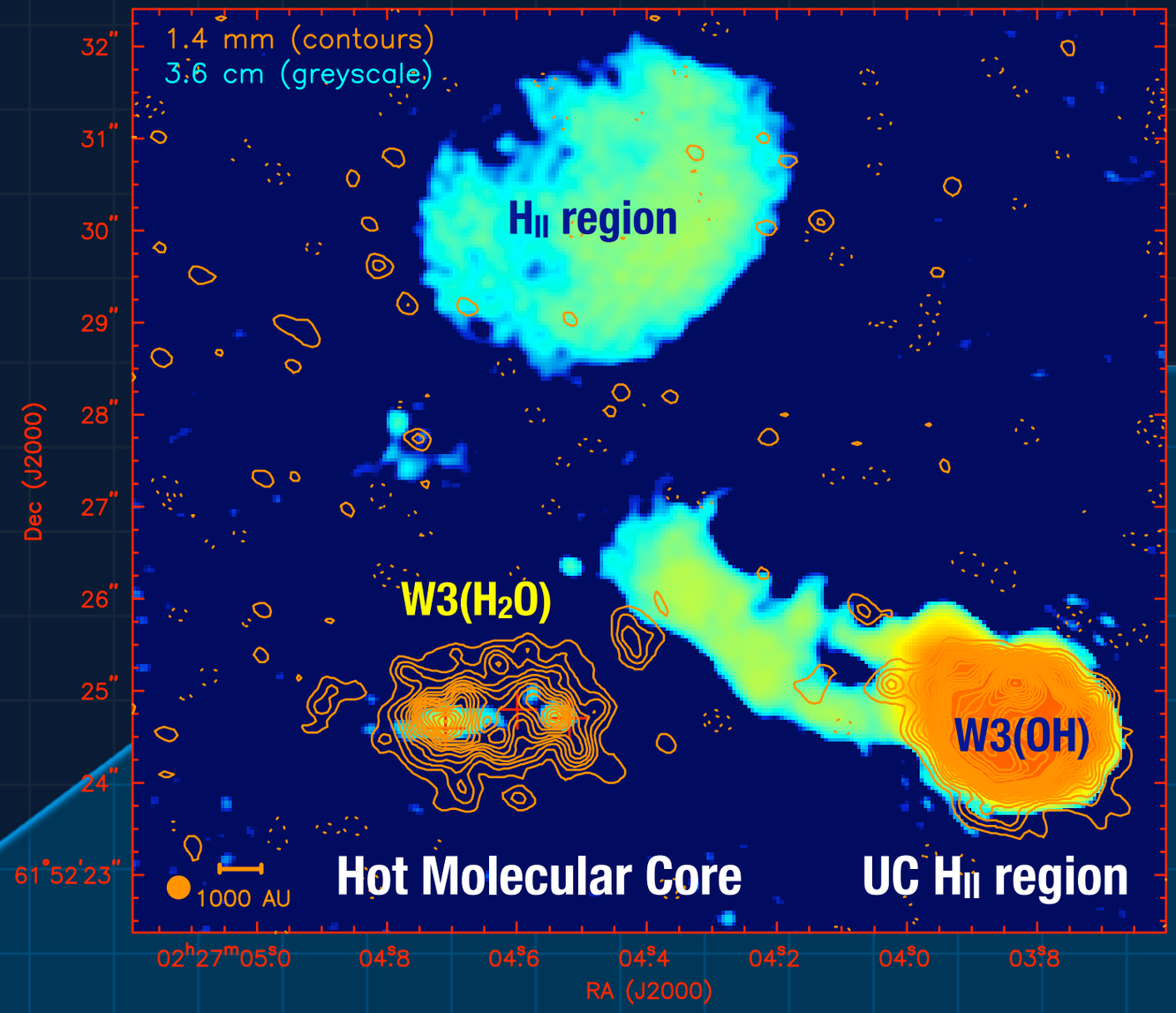
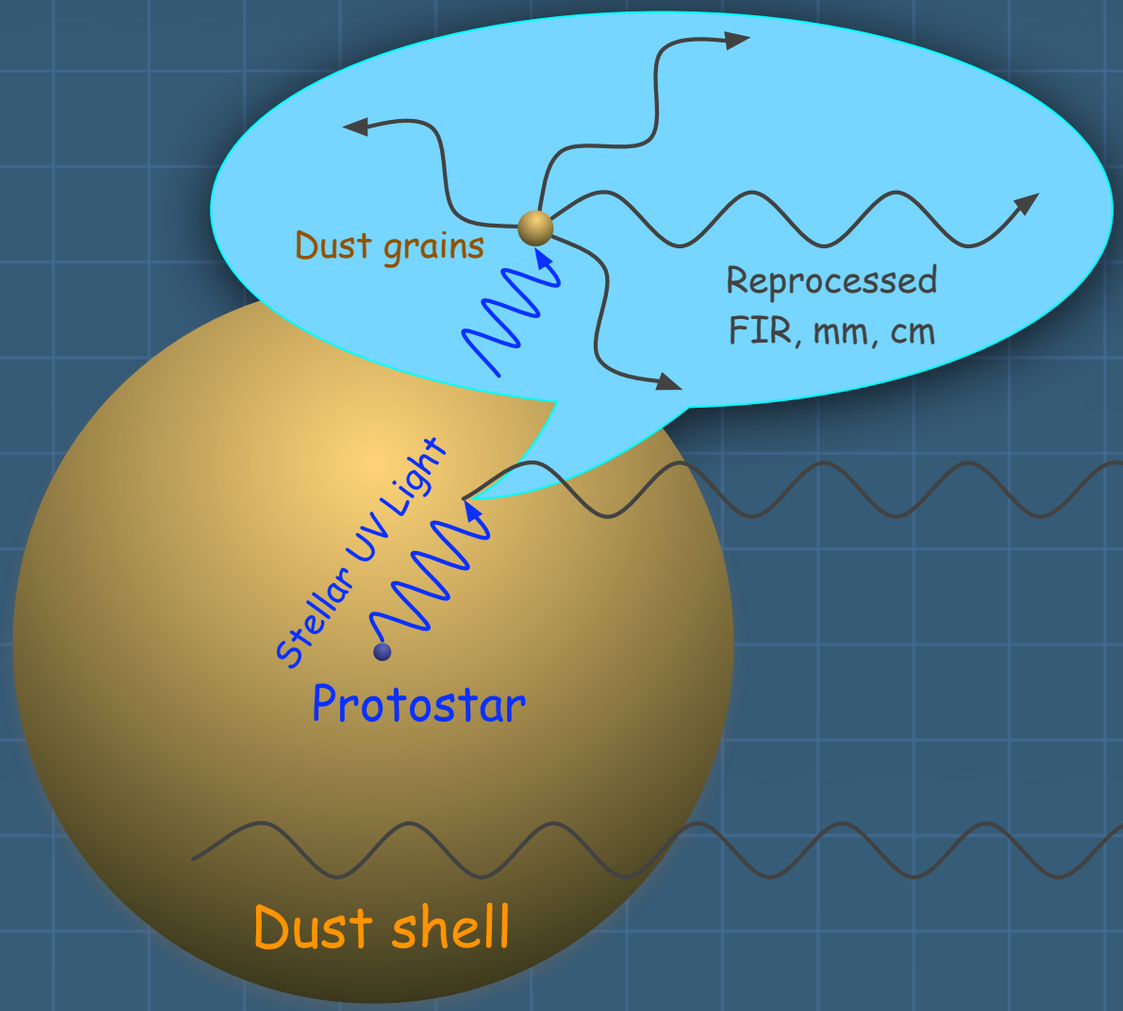
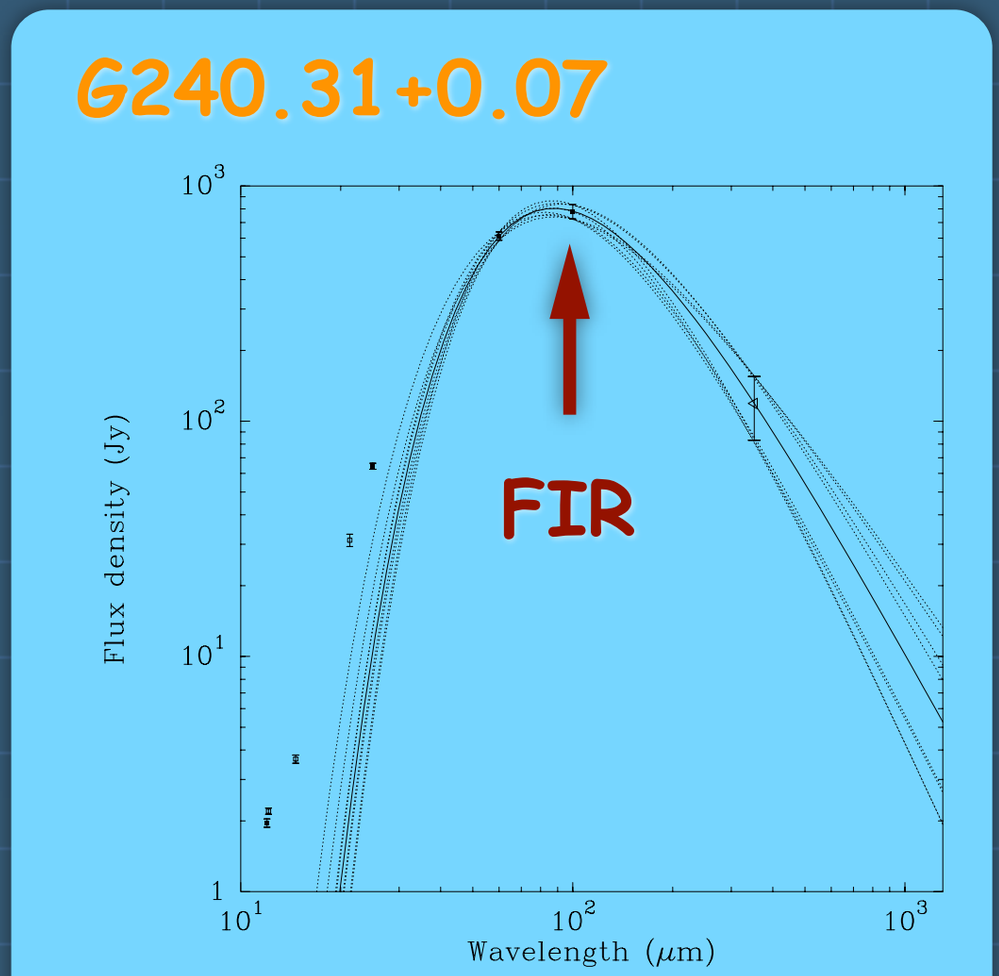


Continuum Emission

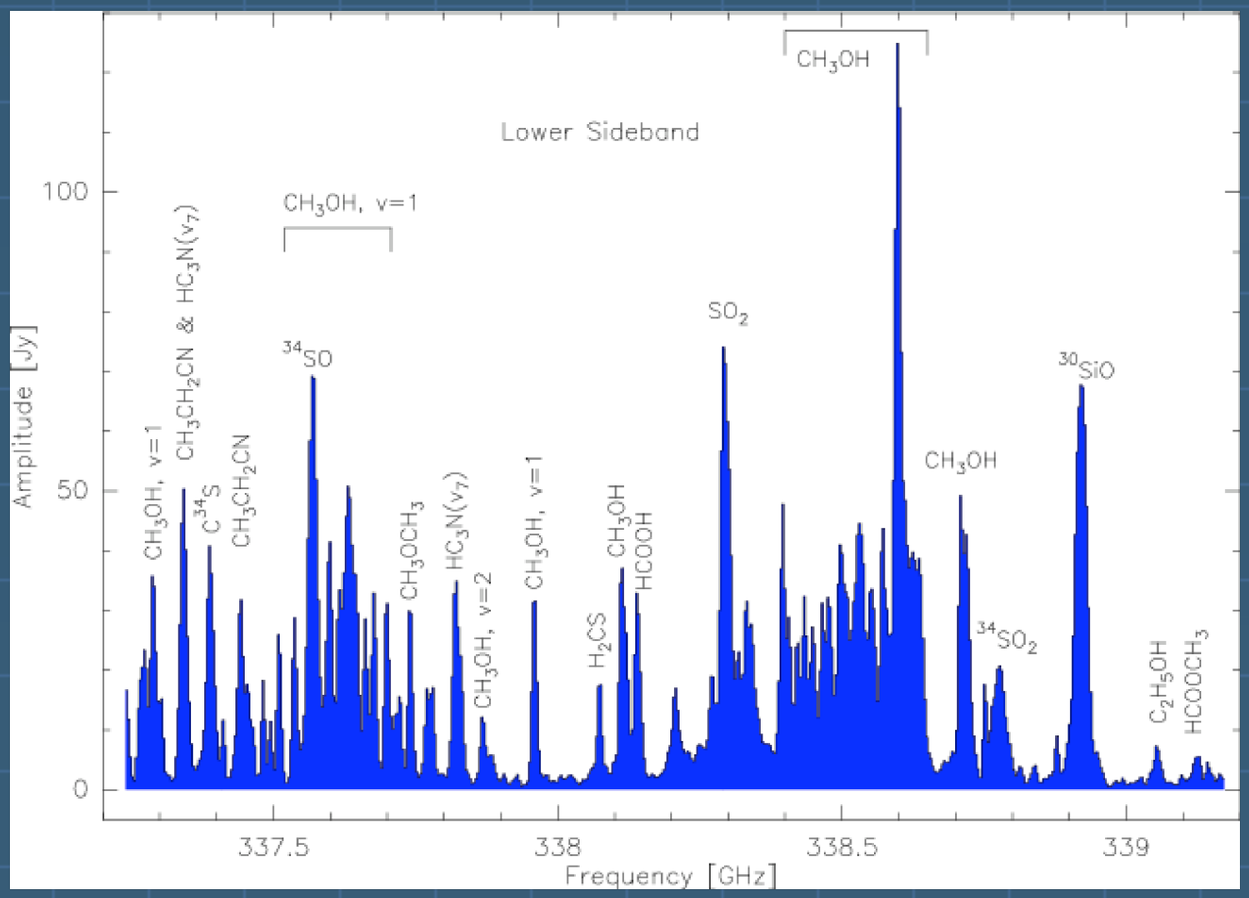


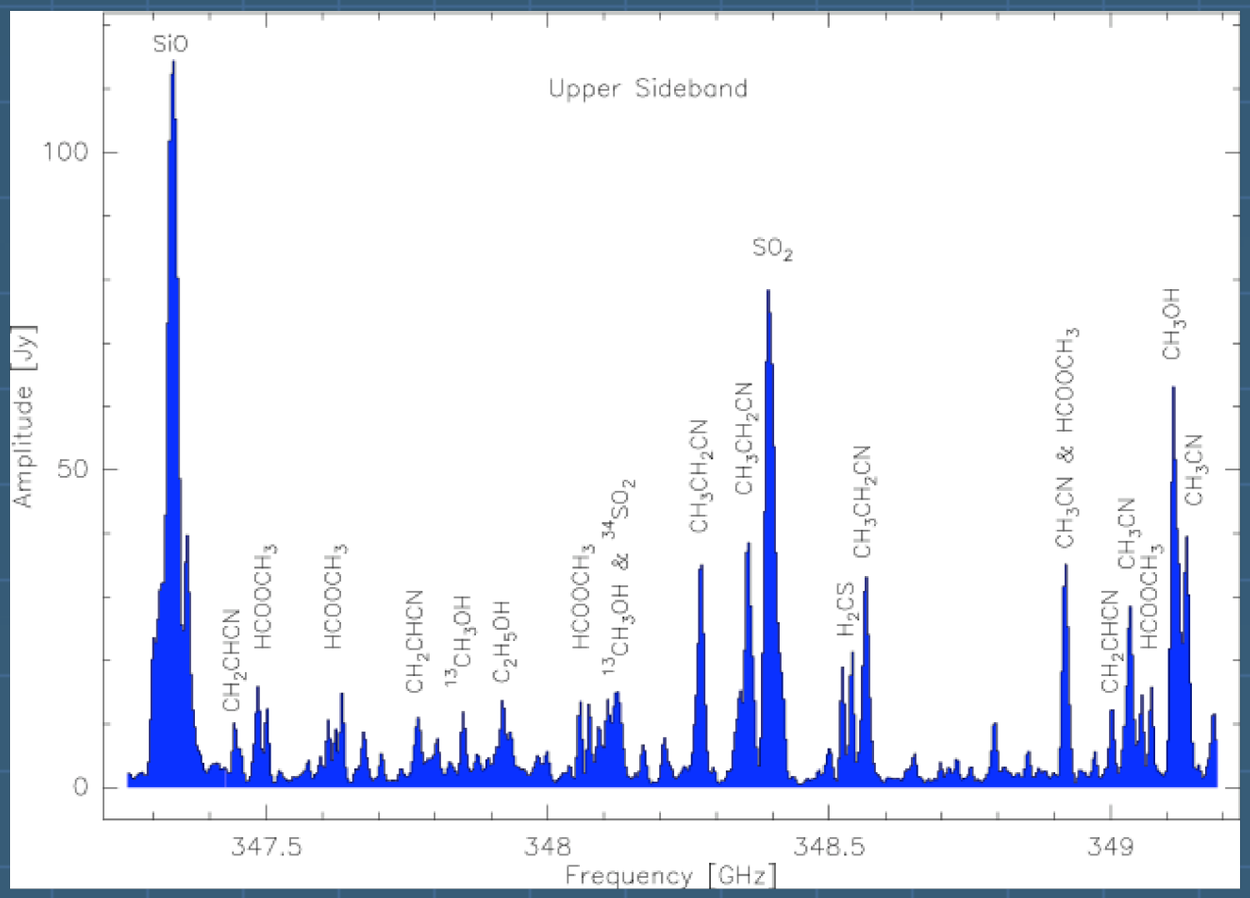


Kumer et al. 2003, A&A, 412, 175

Spectral Line Emission

Hot Core Chemistry

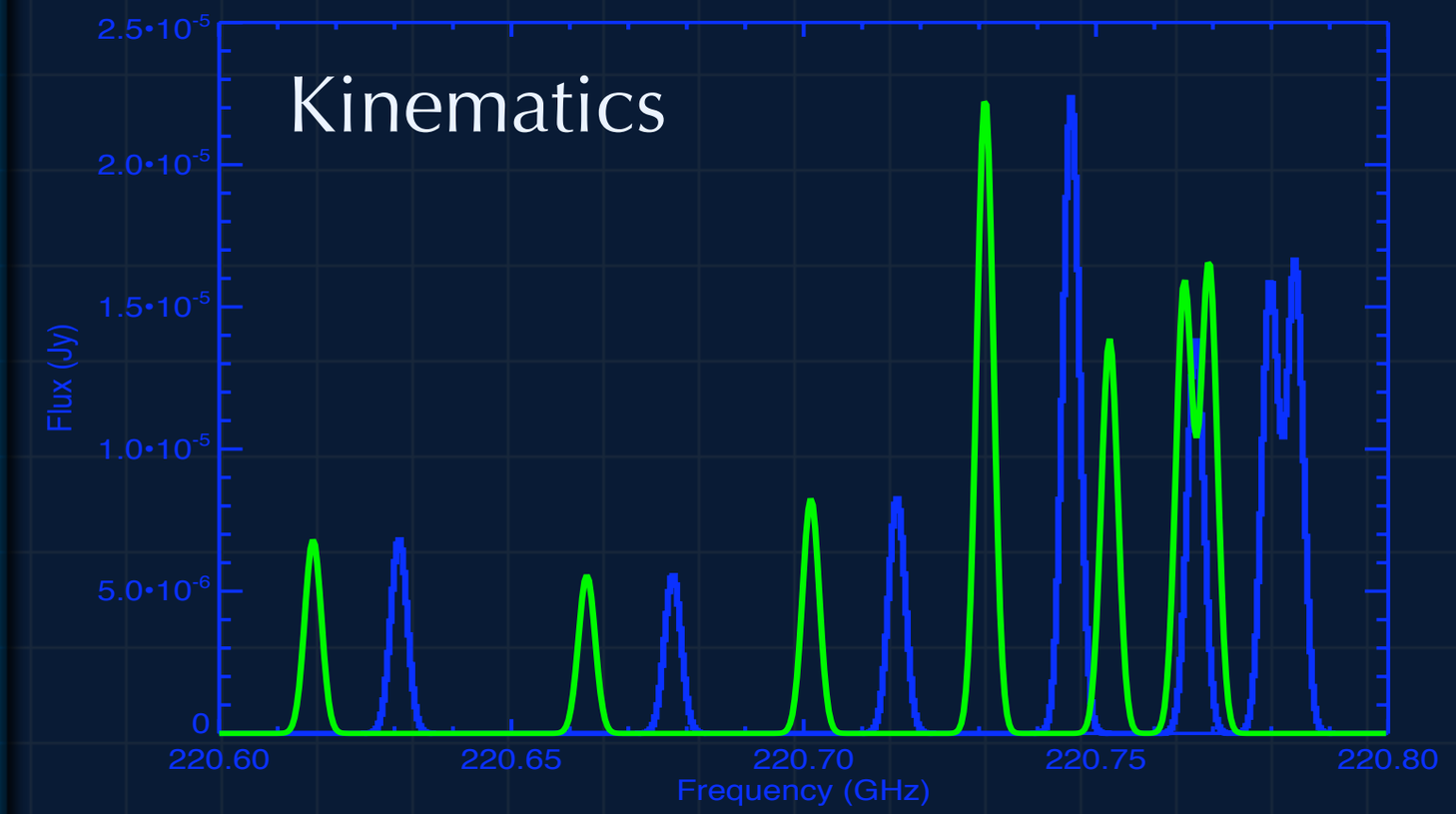


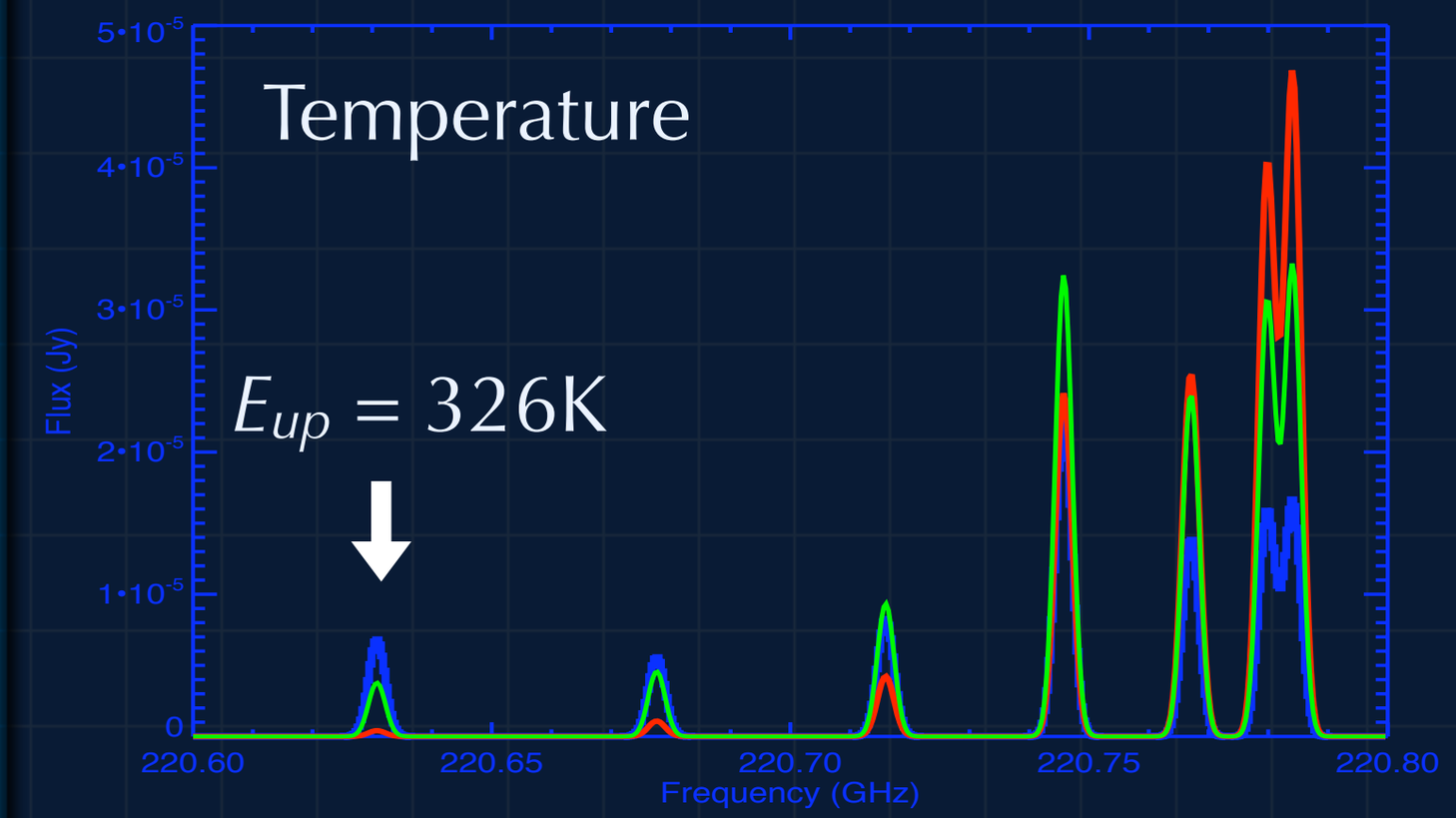


Orion KL

Spectral line Observations

- Deriving velocities - kinematics
- Deriving temperature - thermal structures & heating sources





Global Collapse toward W3(OH)