
Where do stars form?
Why do they form?

# Goals for today

1) Relate different components of gas to the location of star formation and to the types of radiation we detect
2) Identify physical processes that cause gas to collapse to form stars
3) Decode jargon HI, HII, and $H_2$ and “recombination”

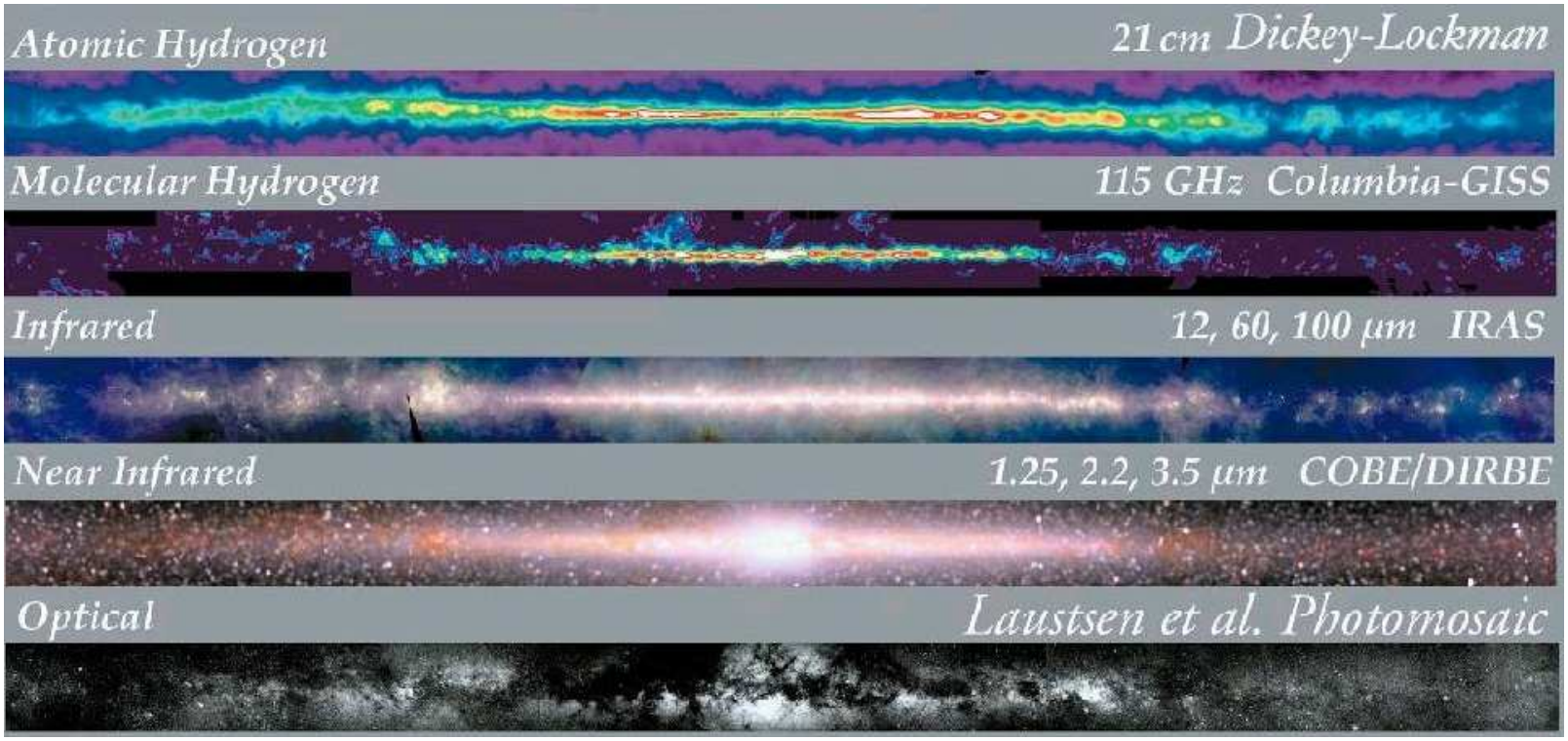
# The Milky Way is full of (mostly hydrogen) gas and dust…

**radio waves: spin flip**

"HI" is atomic H (low density, traced @ 21cm)

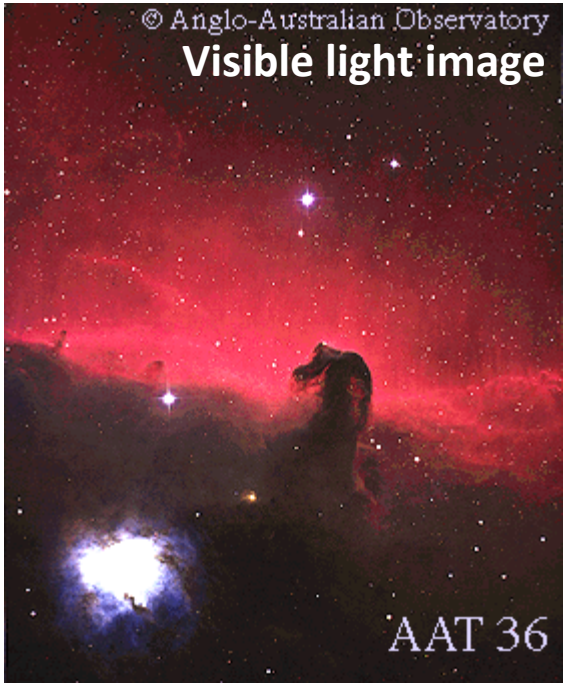
**mm waves: rotation/vibration**

"$H_2$" is molecular (high density, traced by pollutant CO)



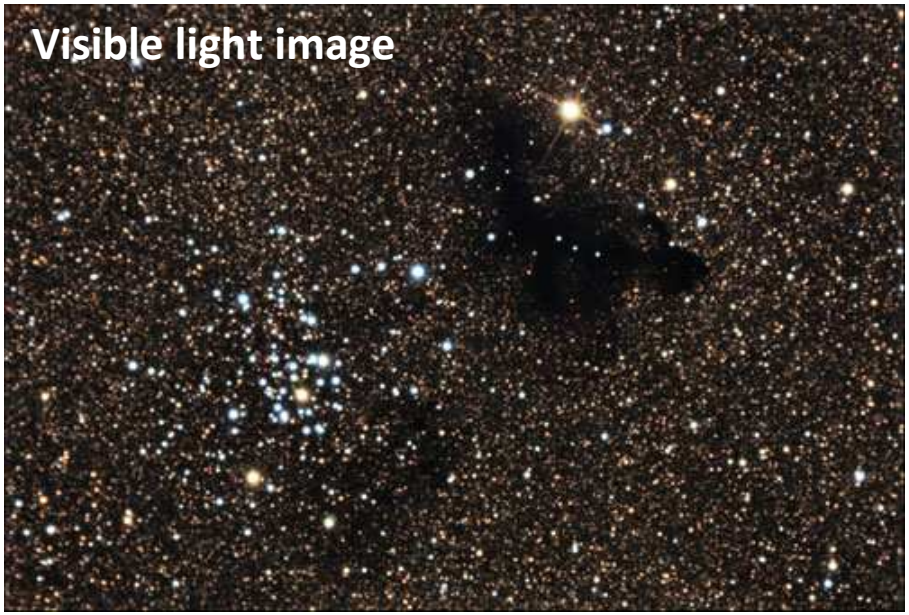

warm dust follows gas; glows as far-IR blackbody

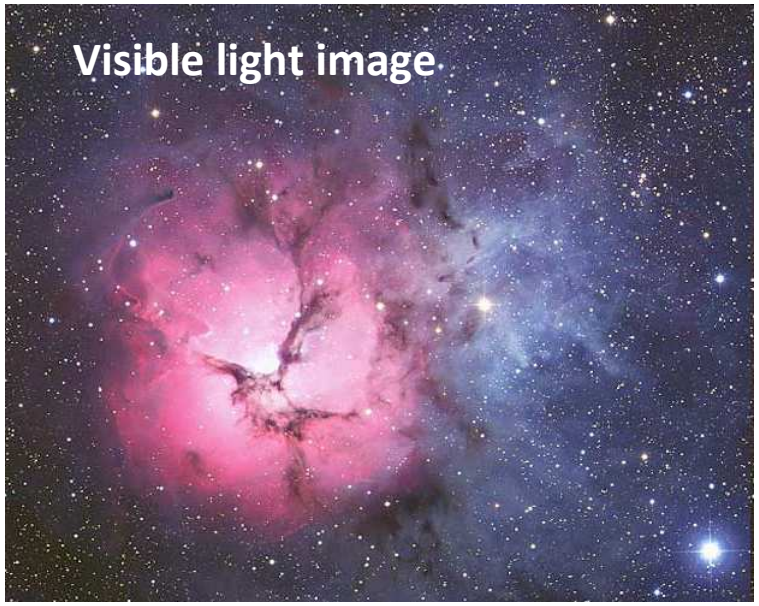
# How do we see interstellar gas and dust in the visible?



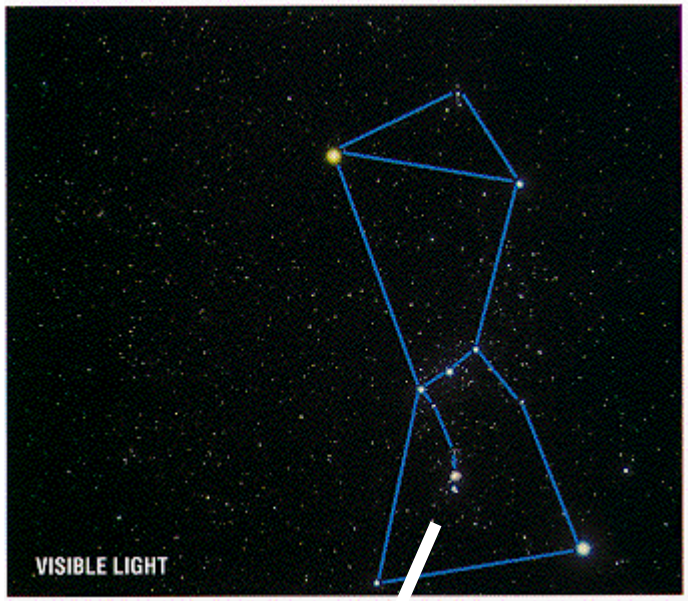

- *diffuse cool gas: reflection/scattering*
- *dense cool gas: extinction/reddening*
- *hot gas: emits lines (red: Hα)*

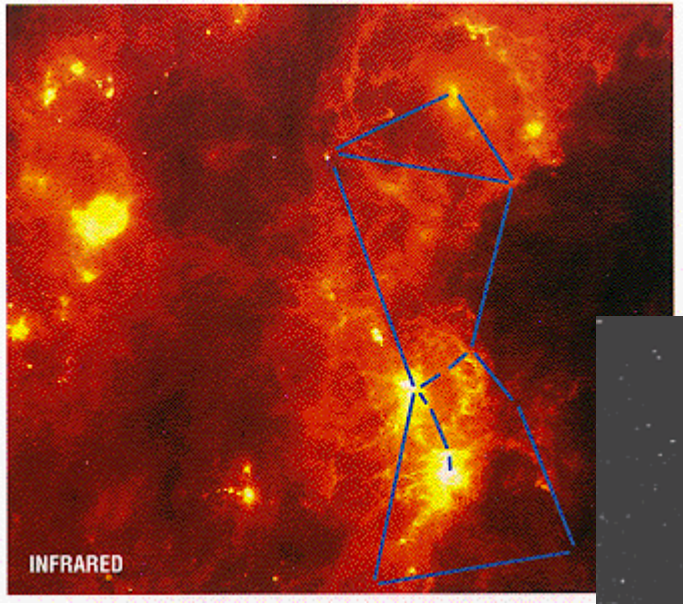
"HII" is ionized (low density, traced by Hα **<u>recombination</u>** line)



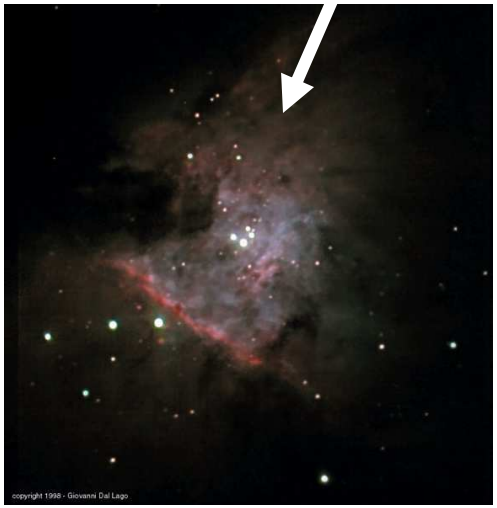
# Stars form in dense gas: is it hot or cold?




CO traces H2

"molecular gas"



O and B stars create "HII" regions: hot ionized gas bubble (why are the edges red??)

# Think-Pair-Share

Put the following in the correct order, first to last:

a) ionized HII region is created

b) dark nebula collapses under gravity

c) O and B stars are born

d) molecular cloud forms

Which occurs third in the sequence?

# Think-Pair-Share

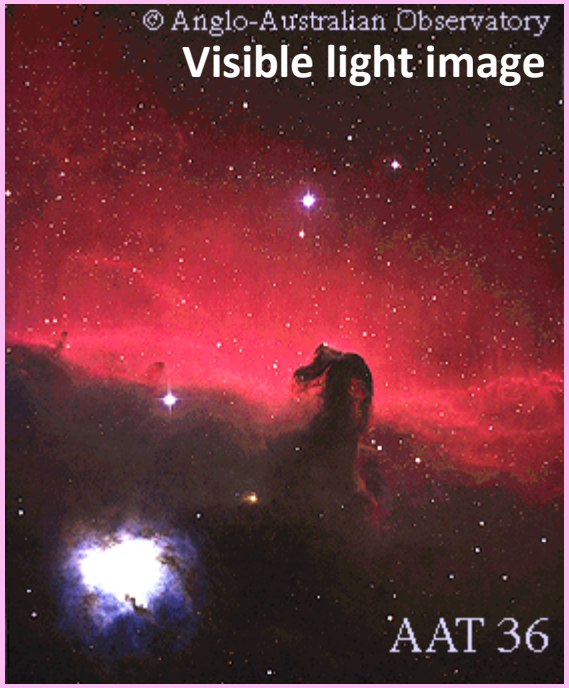
Where do stars form?

A) in cold molecular gas

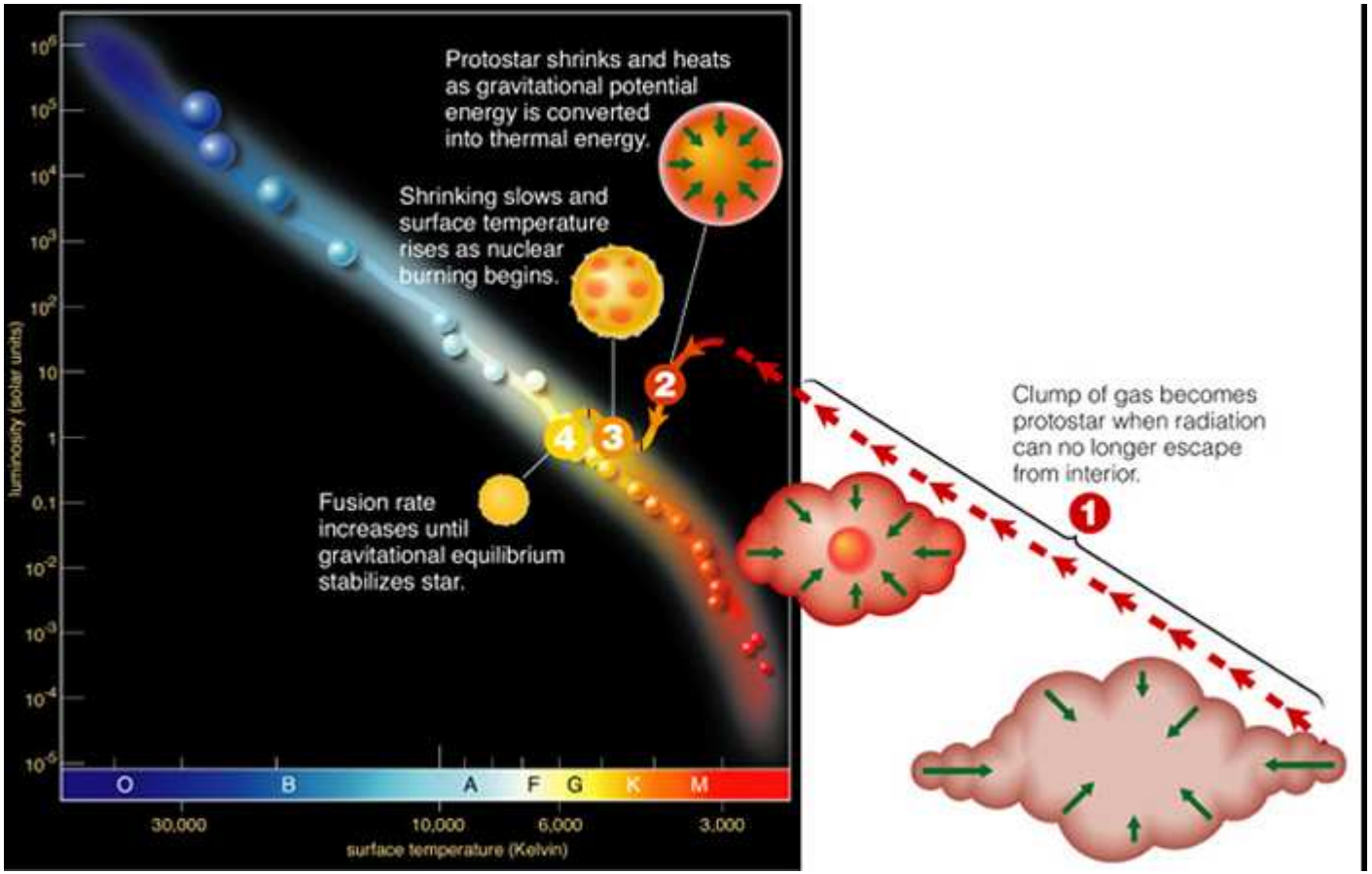
B) in atomic HI gas

C) in HII regions in hot ionized gas

D) all of the above



# Isolated Star Formation

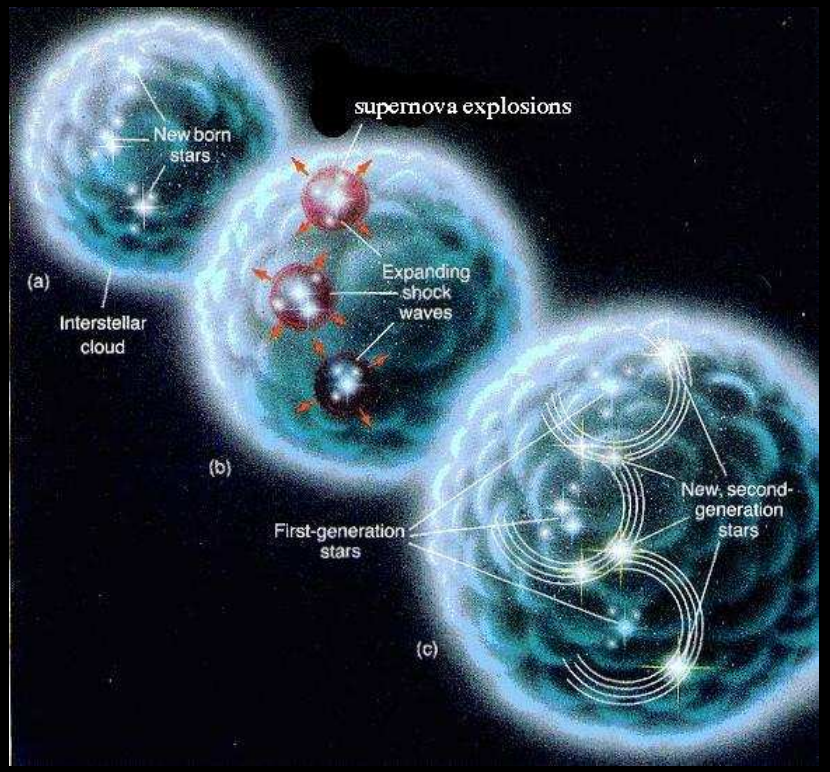



http://www.bramboroson.com/astro/images/protostar_hr.jpg

**What forces act outward?**

# How does the first generation of stars affect further star formation?

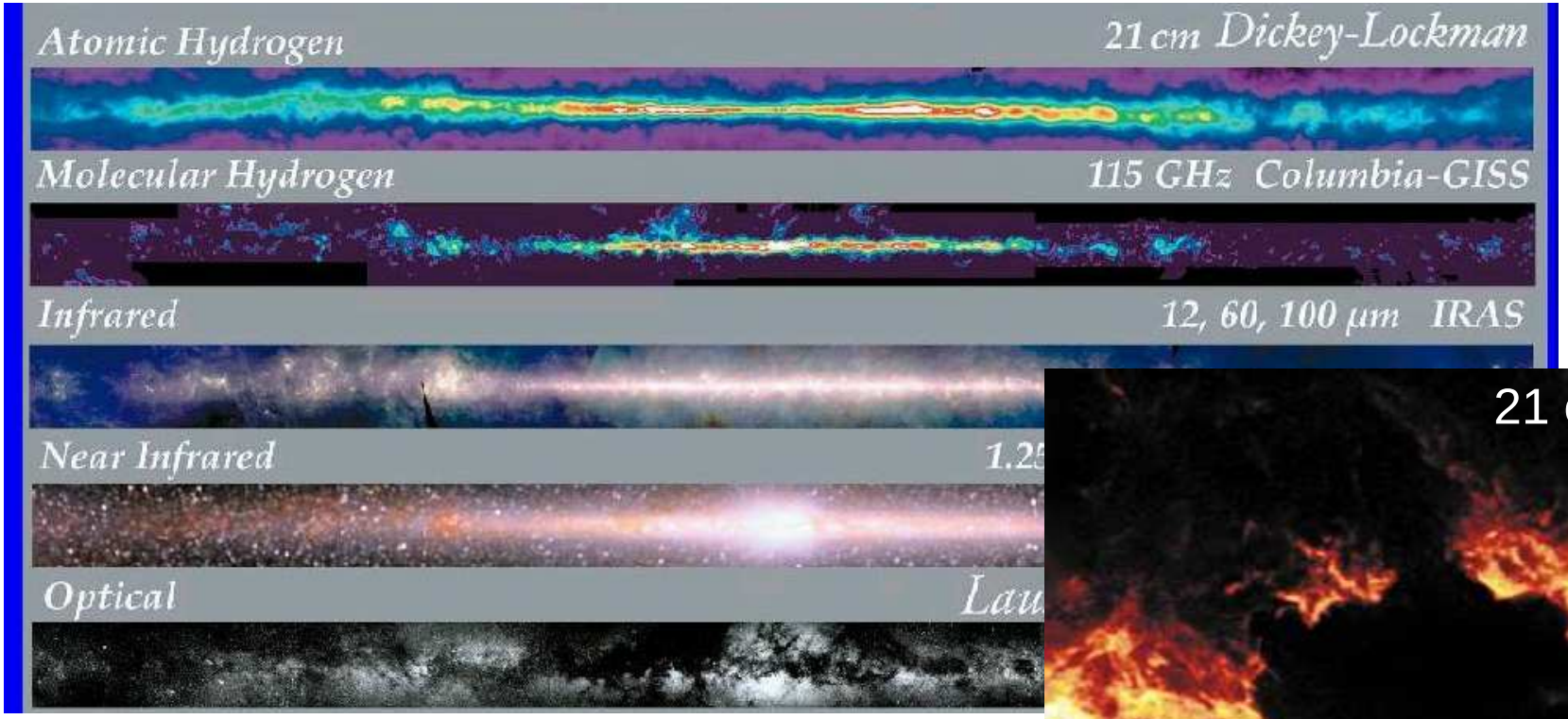
- Outflows, winds, jets compress nearby gas and produce new stars
- Supernova explosions (from O & B stars with short lives) compress nearby gas and produce new stars & star dust
- UV radiation ionizes and heats the gas, limiting the size of the next protostars

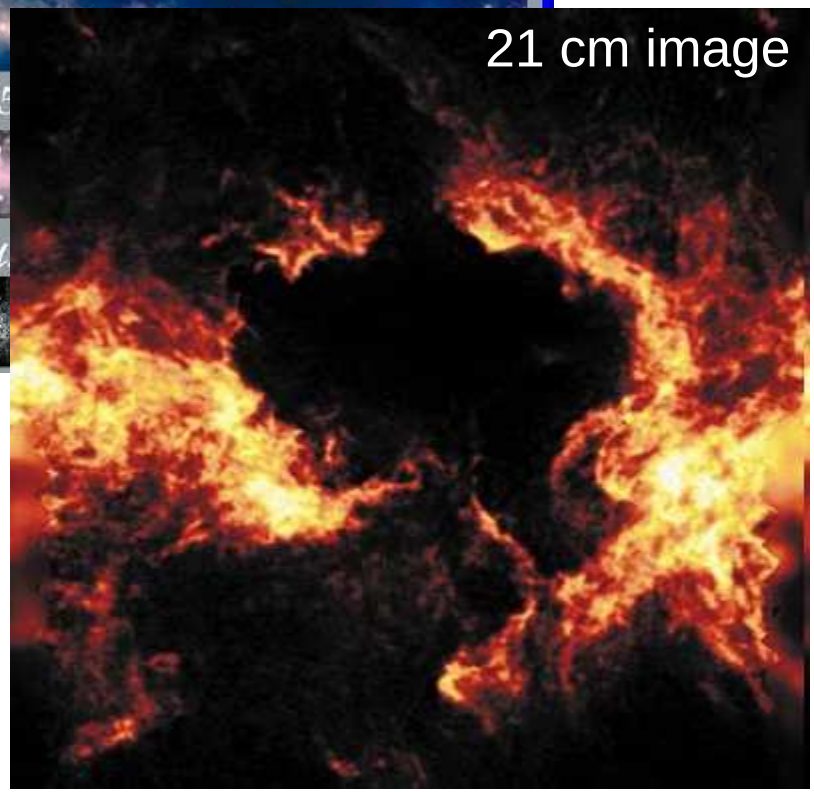



Stars like to form in clusters… but not all do!

*What about our Sun?*

# The 21 cm map of the Milky Way…




has holes in it. Did our Sun form together with whatever made the Local Bubble?

# Think-Pair-Share

Why do stars form?

A) internal pressure loses out to gravity as magnetic field support is lost

B) gravity is enhanced by external compression

C) the cloud interior is too cold to maintain hydrostatic equilibrium

D) astronomers are still figuring it out

# Peer Learning

A star moves toward us at 300 km/s such that its H$\alpha$ line (rest $\lambda$ = 656 nm) is Doppler shifted. At the same time, the star has internal thermal motions with typical speed 30 km/s. Estimate the central wavelength and width of the observed H$\alpha$ absorption line. Which number depends on the direction from which we view the star? How can thermal broadening be distinguished from rotational broadening due to stars spinning on their own axes?