# Introductory Astronomy

## Week 5: Stellar Evolution

## Clip 2: Pre-Main Sequence



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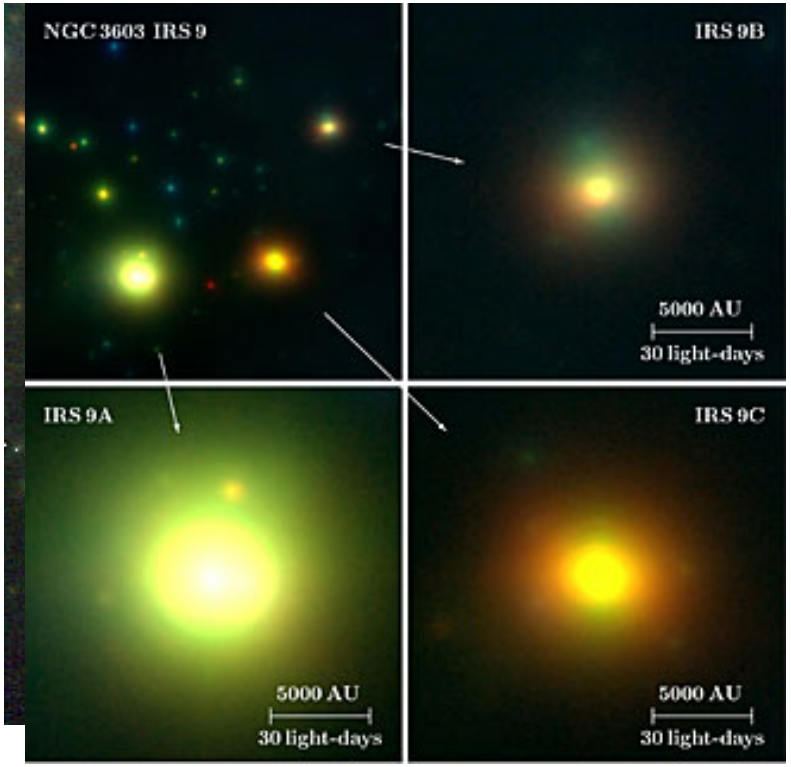
# Modelling Collapse

- Model a cloud of mass $1M_{\odot}$
- Within a few Ky form opaque radiating photosphere of dust and later $H^-$
- Photosphere contracts from $R \sim 5\,\mathrm{AU};\ T \sim 300K$

  to $R \sim 2R_{\odot}\ T \sim 4000\,\mathrm{K}$ at constant $L \sim 10L_{\odot}$ fueled by Kelvin-Helmholtz and deuterium fusion over 600Ky

# Can We See This?

- Protostars hidden in dusty cocoon
- Observe radio and IR emissions
- Deduce structure from intensity in bands and lineshape



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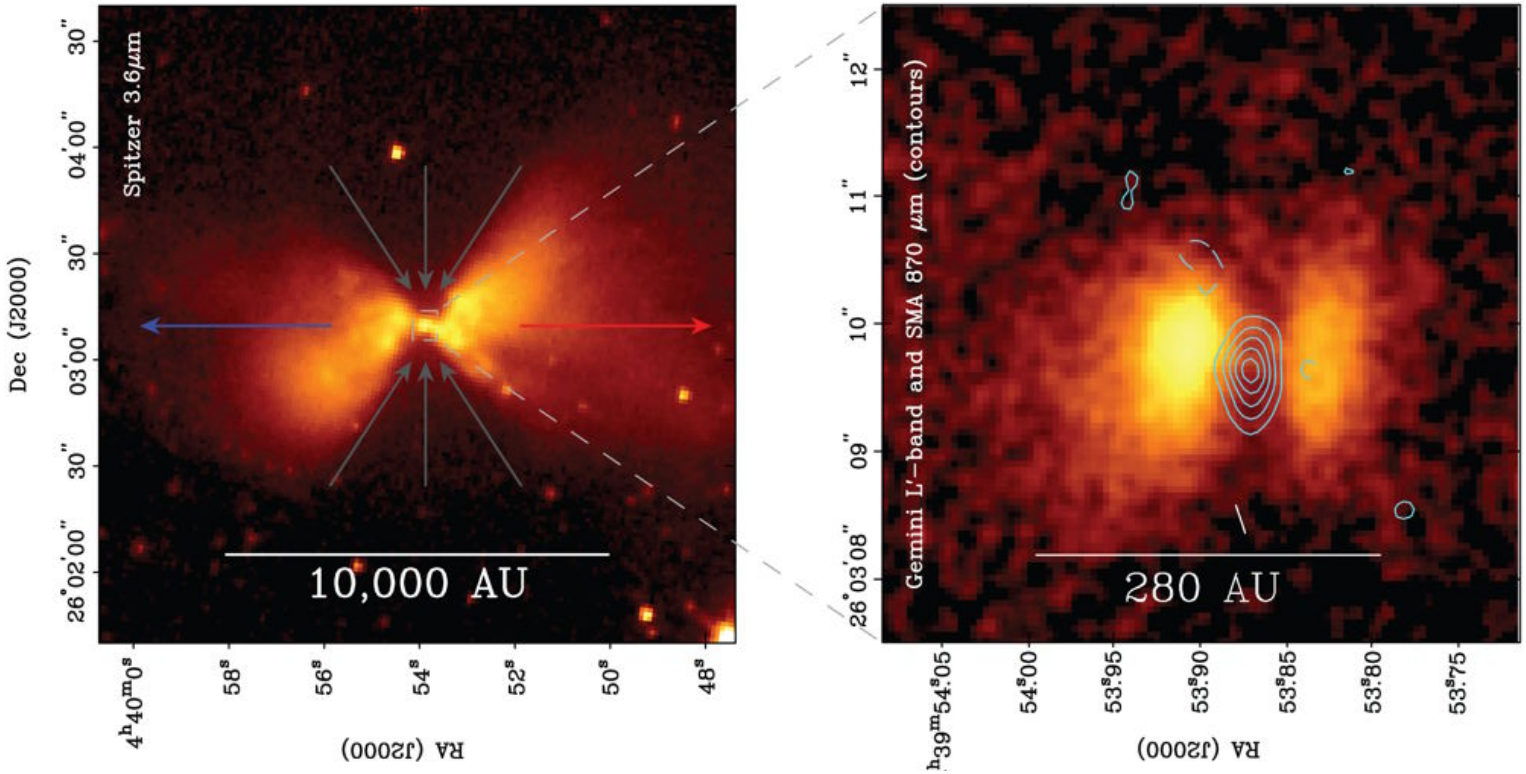
# L-1527



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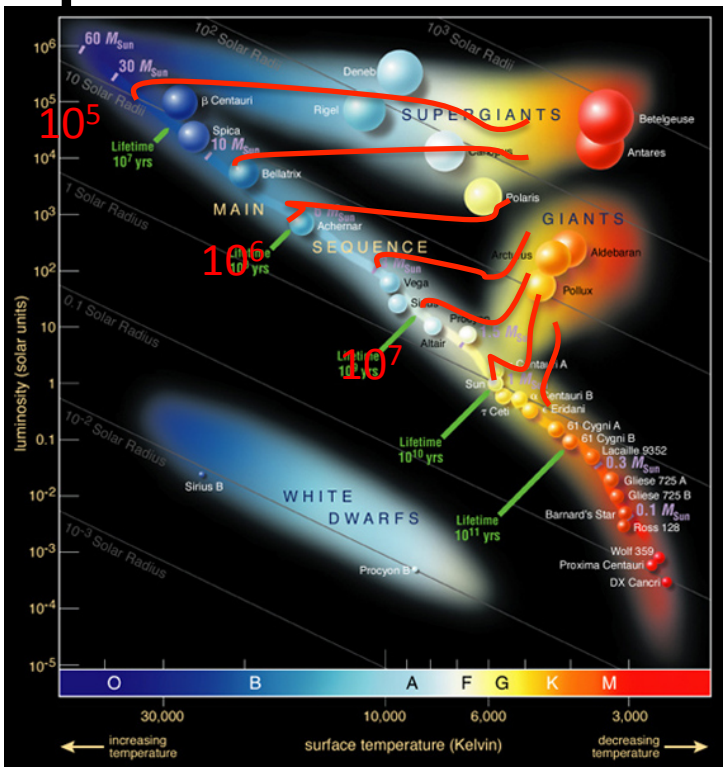
# Pre-Main Sequence

- Initial photosphere contracts at constant T decreasing L
- Rising ionization in center reduces opacity creating radiative zone increasing L
- When fusion begins L decreases initially as core expands
- In 40My settle down to MS equilibrium: KH time!
- Larger stars go faster



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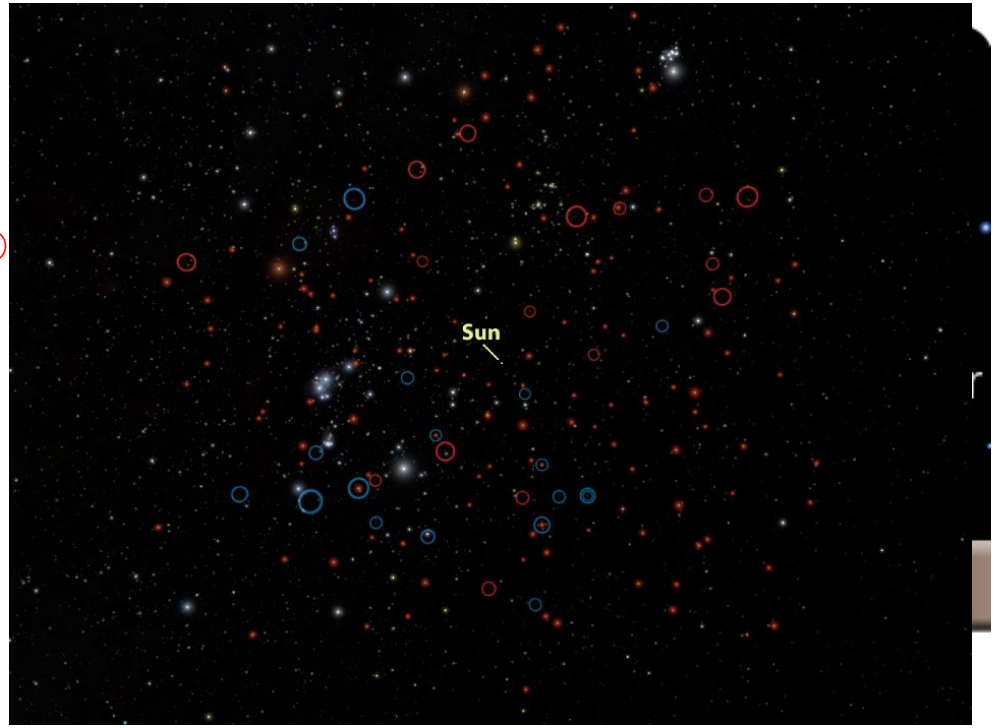
# Too Small

- Below $0.072M_\odot$ effective fusion does not occur
- $0.013M_\odot \leq M \leq 0.072M_\odot$ is a brown dwarf type L, T, Y
- How Many? 1:1? 1:5?



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# Too Big?

- Models suggest that collapse with $M \gtrsim 200 M_\odot$ fails as radiation pressure fragments cloud
- Recent record $M \sim 265 M_\odot$




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# Credits

- Protostar Images: ESO http://www.eso.org/public/images/eso0317c/ http://www.eso.org/public/images/phot-16d-03/
- Brown Dwarf Gliese 229B: NASA http://starchild.gsfc.nasa.gov/Images/StarChild/questions/brown_dwarf.jpg
- Brown Dwarf Survey: NASA/JPL-Caltech http://www.nasa.gov/mission_pages/WISE/multimedia/pia15637.html
- RMC 136a Images: ESO/P. Crowther/C.J. Evans http://www.eso.org/public/images/eso1030d/
- RMC 136a Size Comparison: ESO/M. Kornmesser http://www.eso.org/public/images/eso1030b/