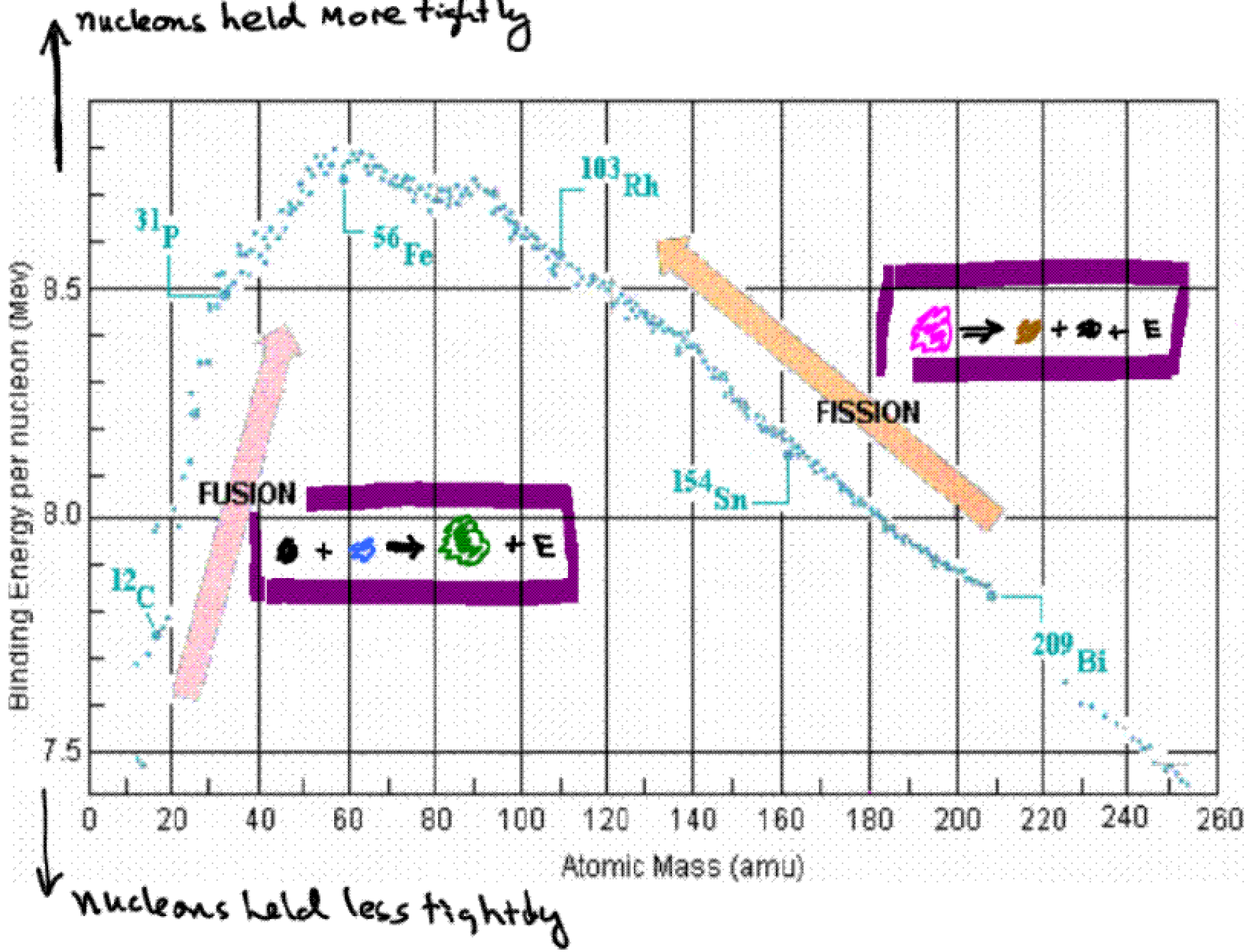
Physics 102 - October 28, 2009

- Project - groups formed
  - webpage - update
  - Start digging a bit
  - email questions
  - Meetings after Nov. 9

- No lectures in Hoyt Next week (Nov. 2 + 4)
  - Monday, Nov. 2 → PDF + MP3 lecture
  - Wed., Nov. 4 → watch Parallel Universes

Inherent Nuclear stability as function of nuclear size



The life cycle of Stars

Gas in the interstellar medium

1 atom per ~ 20 cubic centimeters

89% H

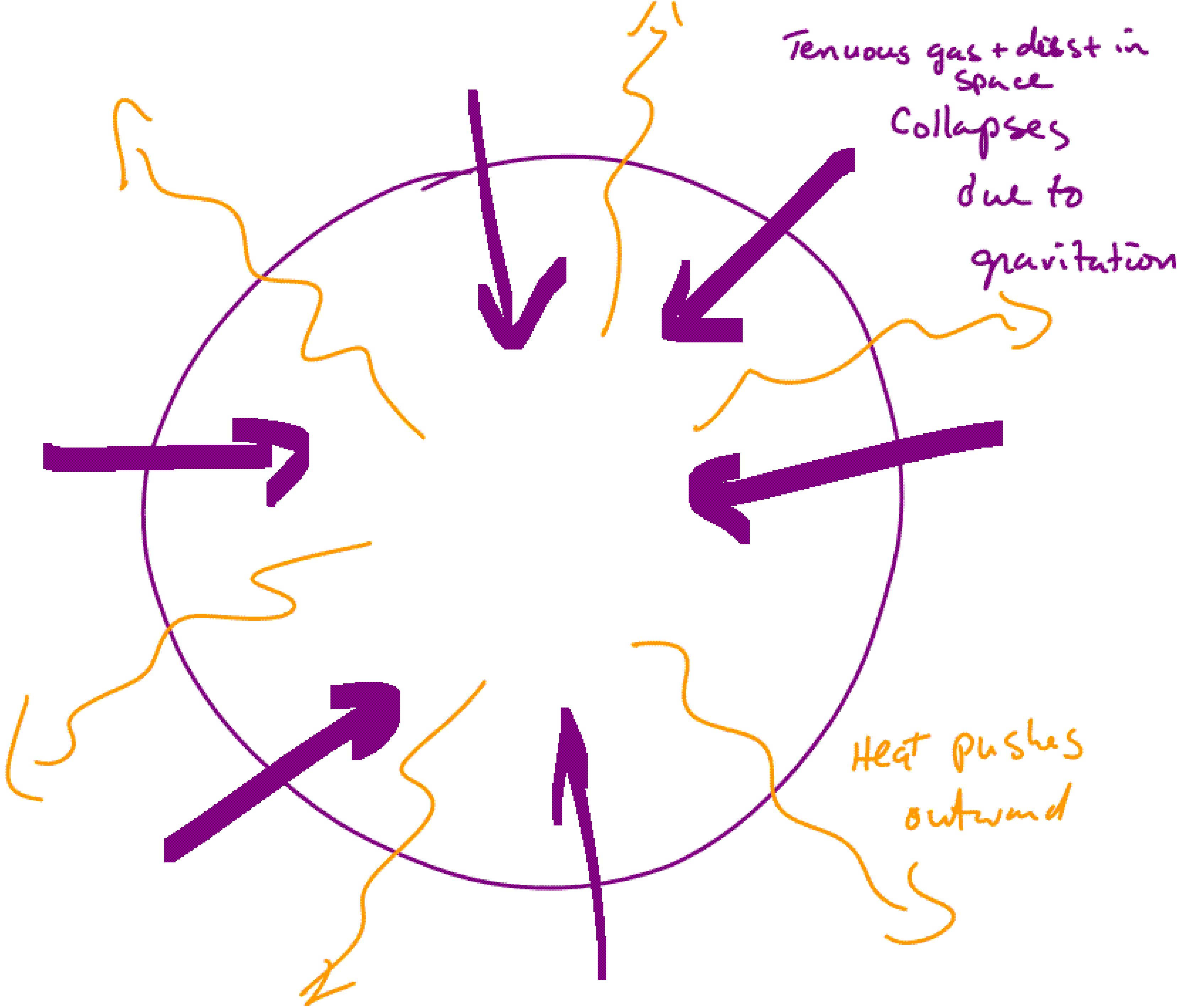
9% He

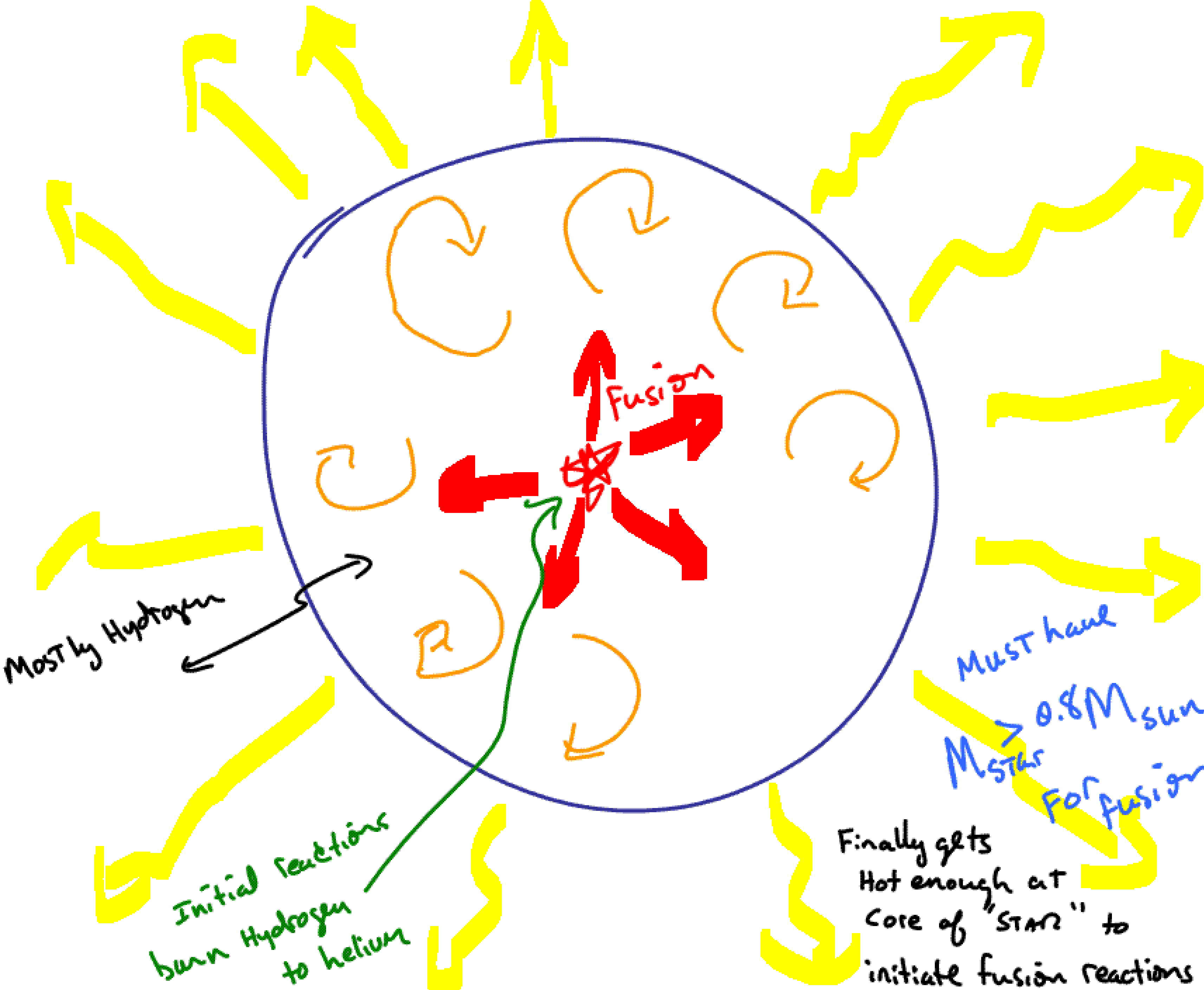
2% elements w/ Z > 2

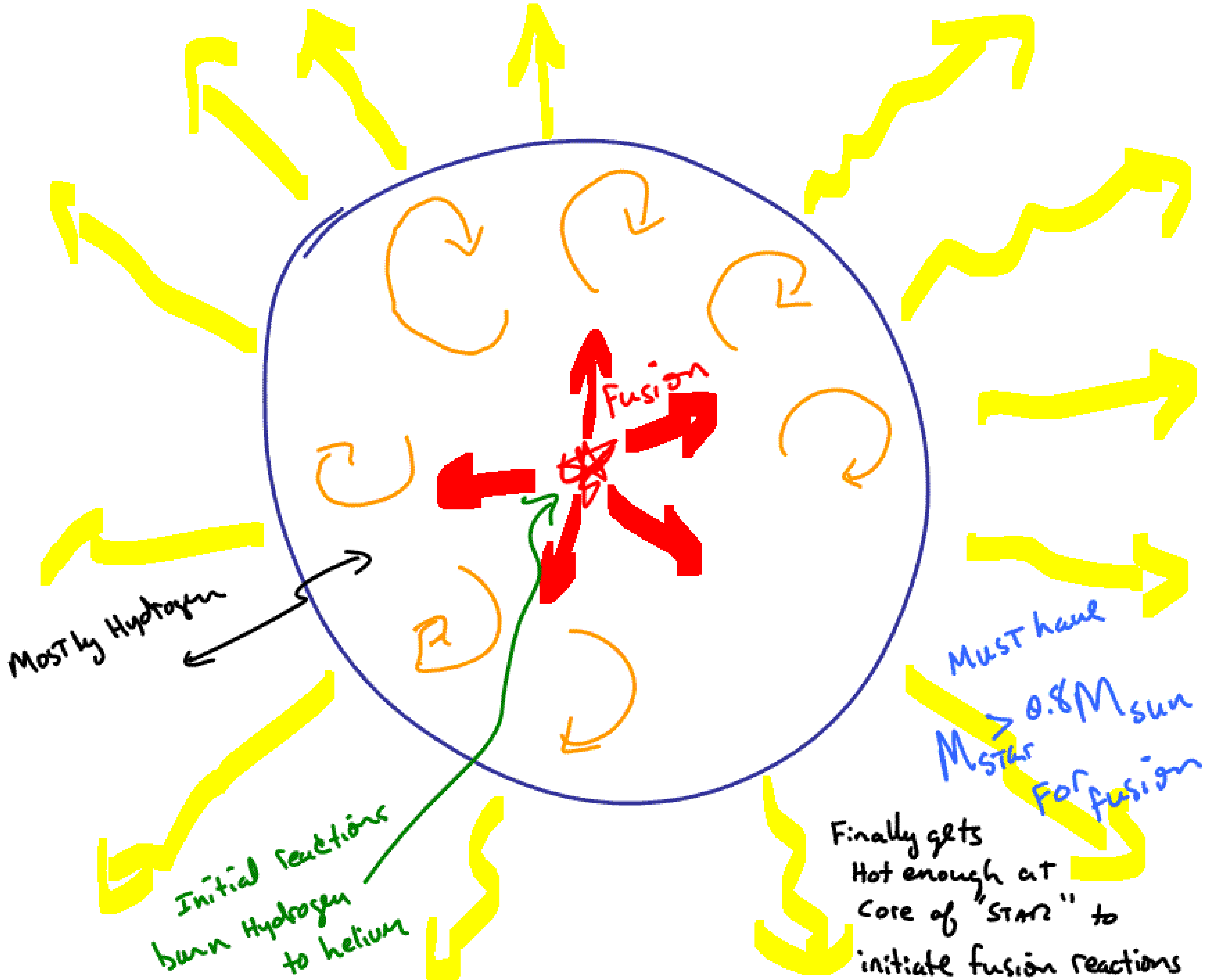
light elements mostly Big Bang nucleosynthesis with contribution from fusion in stars

Heavyish elements from stellar fusion + Novas + supernovae

Much more on this later


Tenuous gas + dust in space
Collapses due to gravitation
Heat pushes outward


Fusion
Mostly Hydrogen
Must have
$M_{star} > 0.8 M_{sun}$
For fusion
Initial reactions
burn Hydrogen
to helium
Finally gets
Hot enough at
Core of "STAR" to
initiate fusion reactions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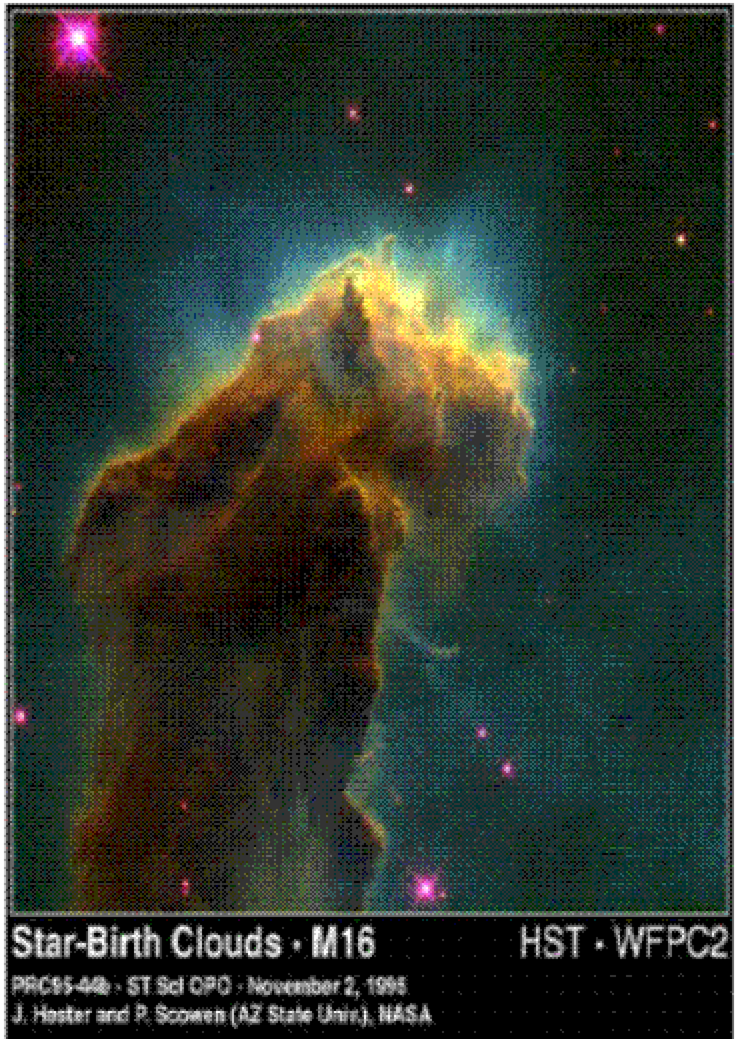
Stars - from dust to dust

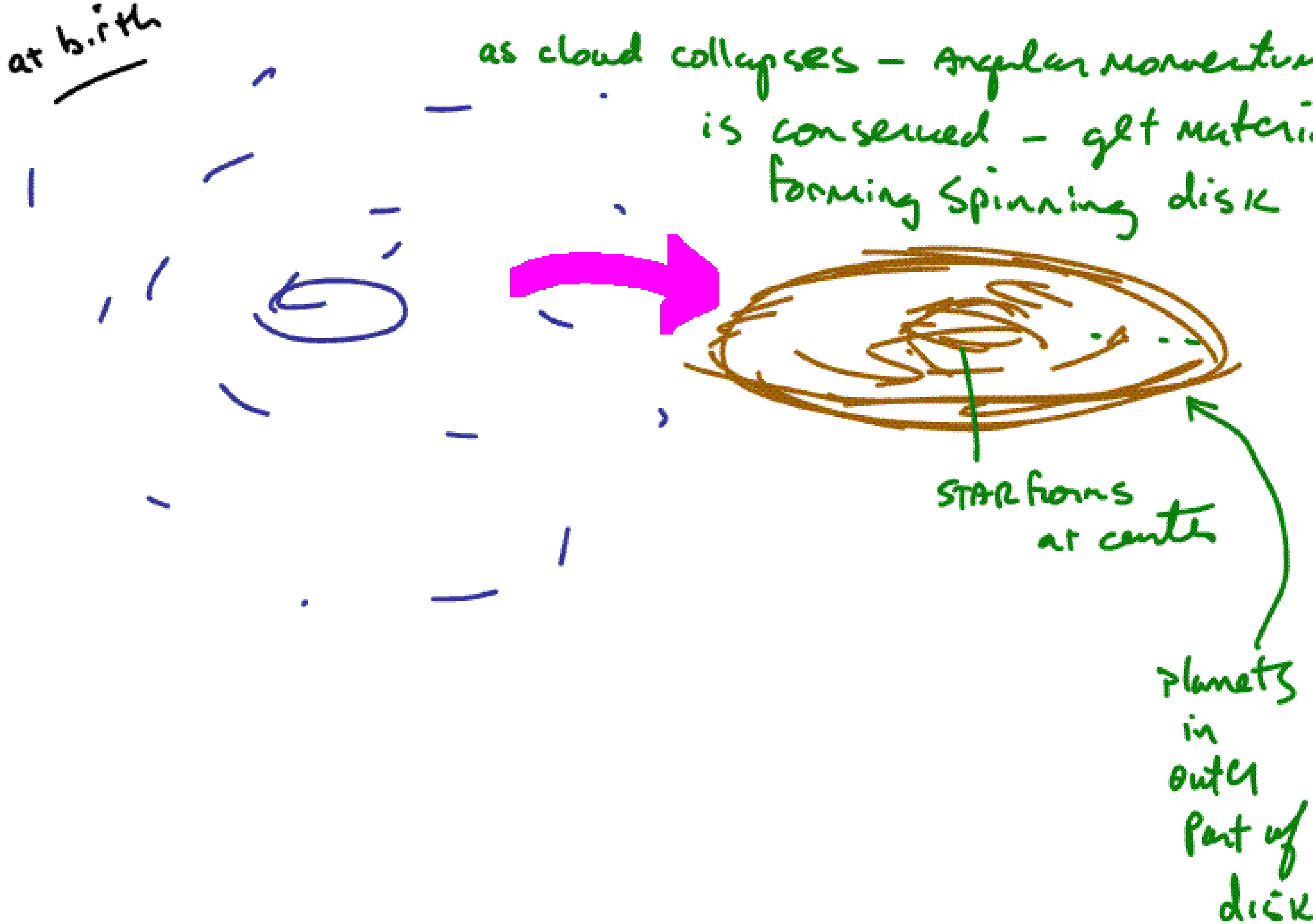


Stars form from
condensation of gas/dust
due to gravitation

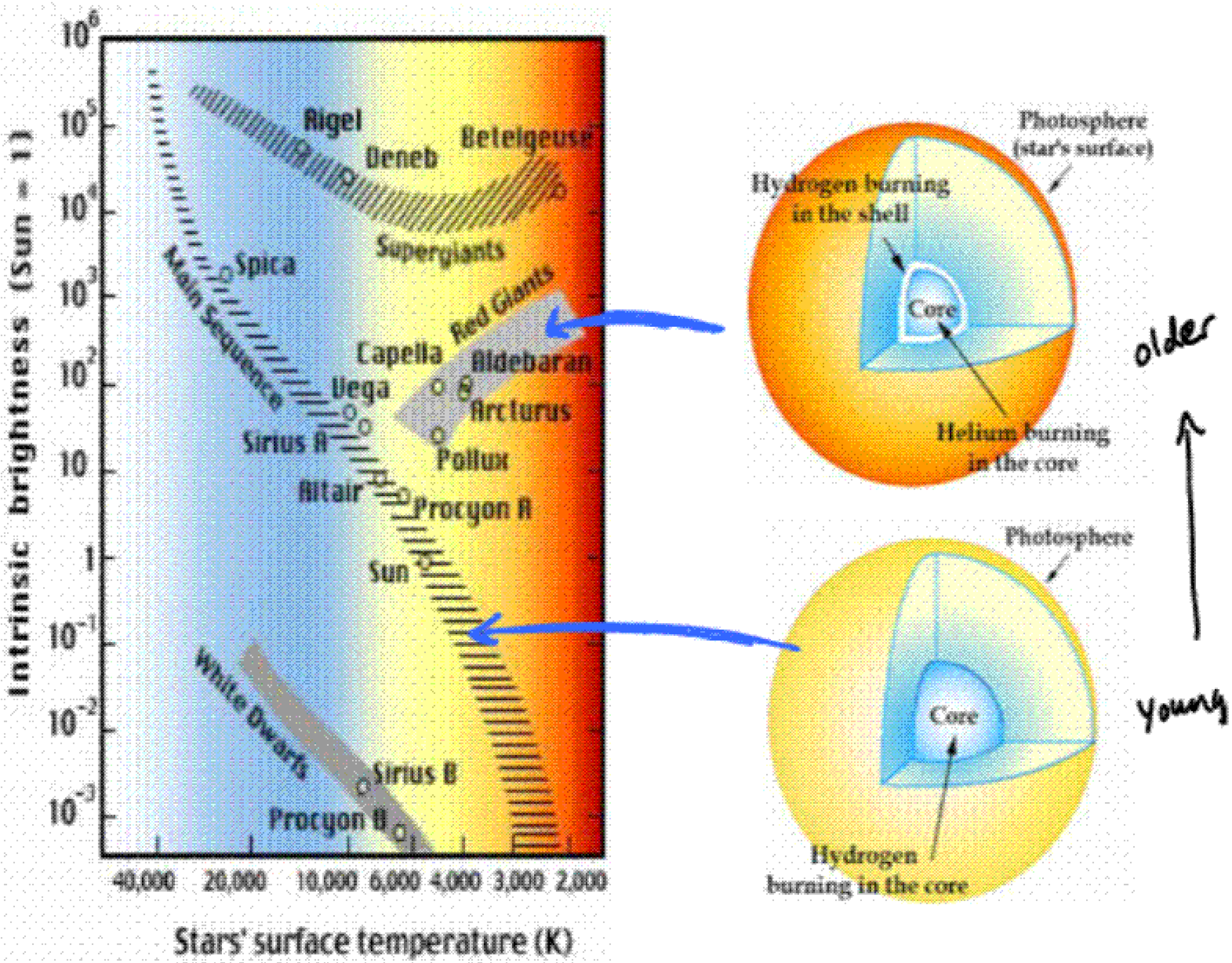
Mostly hydrogen gas

The Pleiades

Young stars residual dust
surrounding them

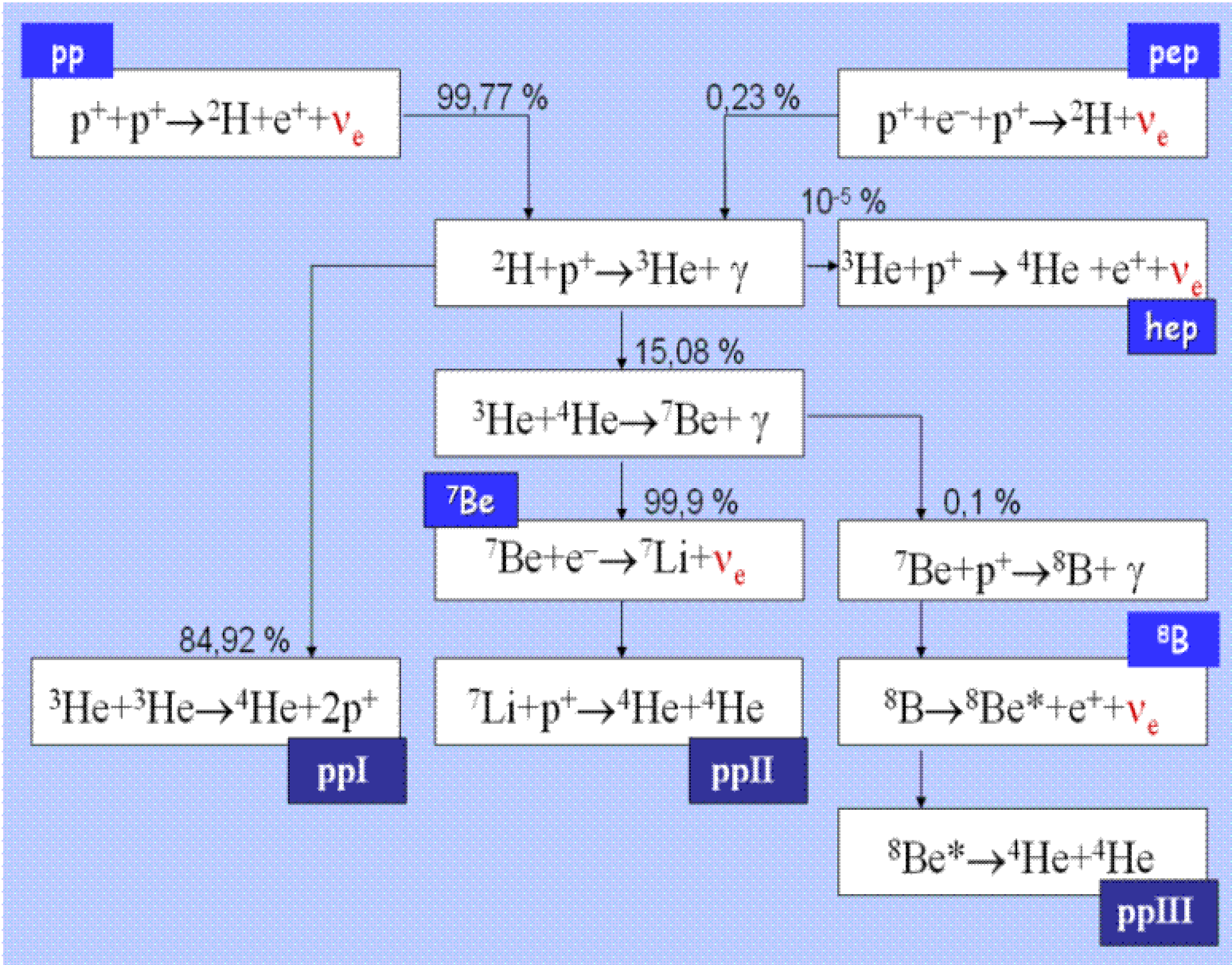


at birth
as cloud collapses – Angular Momentum is conserved – get material forming spinning disk
STAR forms at center
planets in outer part of disk

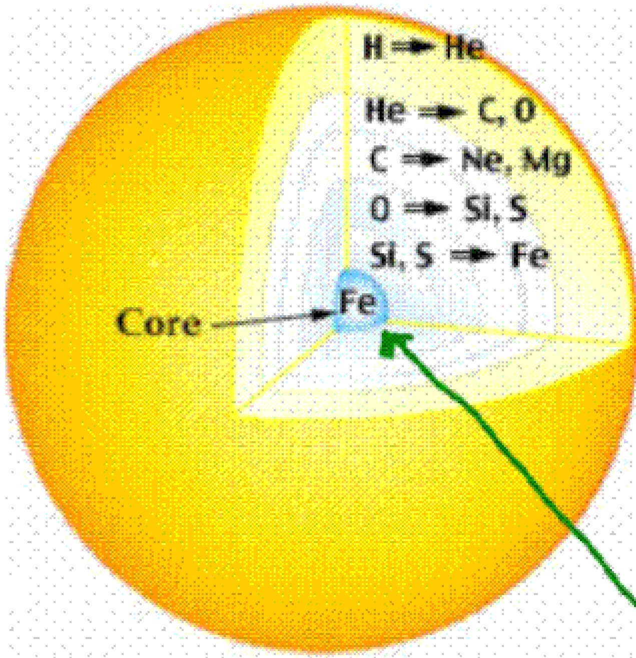


Intrinsic brightness (Sun = 1)
10^6
10^5
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
40,000
20,000
10,000
6,000
4,000
3,000
2,000
Stars' surface temperature (K)
Rigel
Deneb
Betelgeuse
Supergiants
Spica
Main Sequence
Red Giants
Capella
Aldebaran
Vega
Arcturus
Sirius A
Pollux
Altair
Procyon A
Sun
White Dwarfs
Sirius B
Procyon B
Photosphere (star's surface)
Hydrogen burning in the shell
Core
Helium burning in the core
Photosphere
Core
Hydrogen burning in the core
older
young

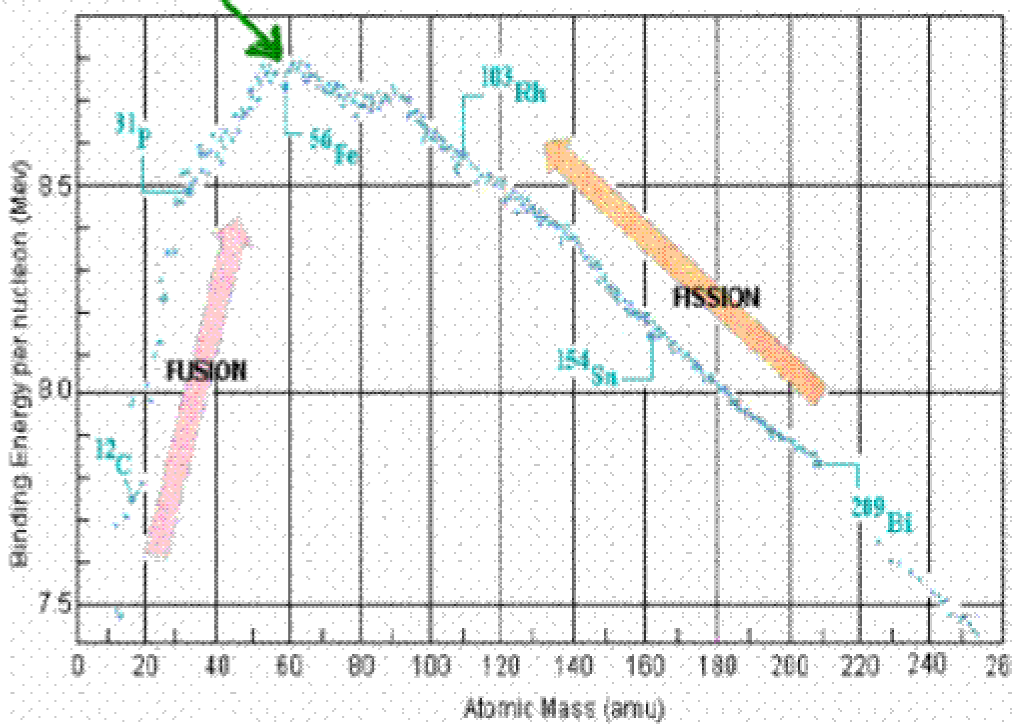
Primary Fusion Processes in the Sun

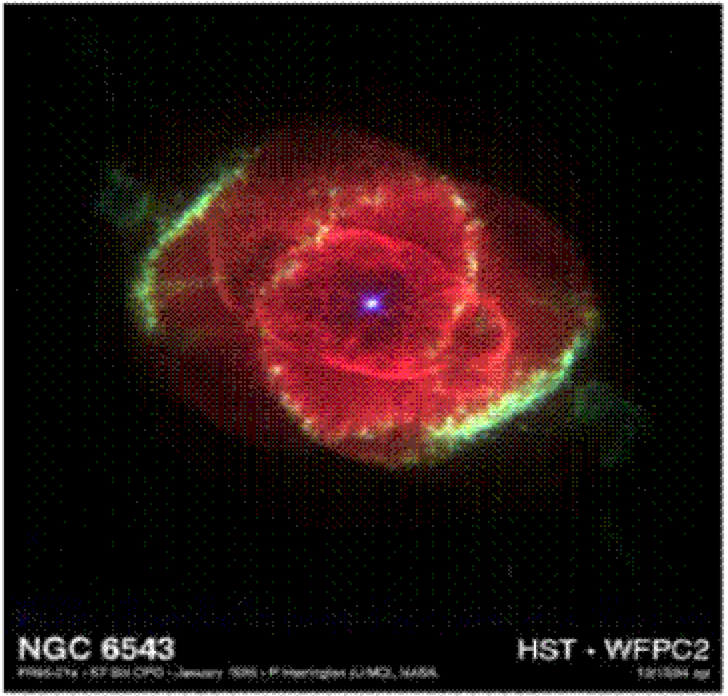


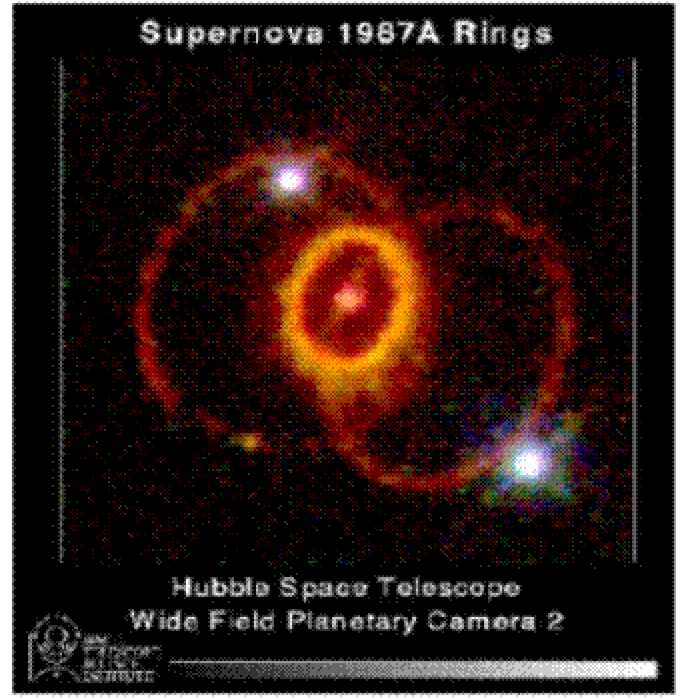
late life massive star



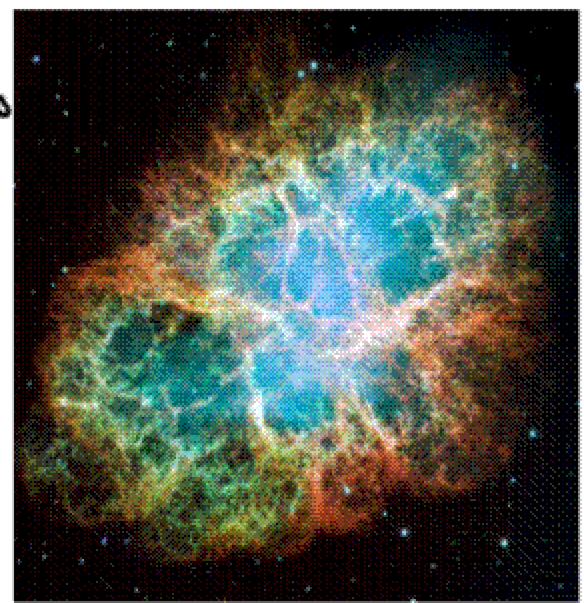
fusion process into nuclei larger than ^{56}Fe takes energy rather than releasing energy







STAR went Supernova in 1054 – observed during day by Chinese and Arab Astronomers



Crab Nebula

Star went Super Nova in 1054

A = 57

Elements with Atomic mass < that for iron can be made in Stars via fusion

How do we get elements with $A > 57$?

And how do these materials get dispersed into space to become part of other stars + planets ?

Nova

Several types

still active area of research

+

Supernova → as core of massive star cools down can have instability — core can collapse due to gravity and then slow or rebound as reach the point where "held up by particles". Shockwave can propagate and ignite the outer layers of STAR

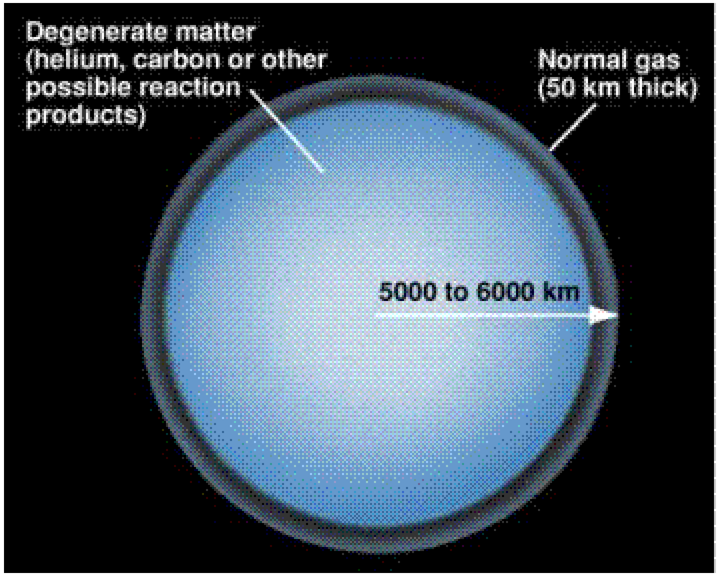
→ Massive explosion

→ Produces heavy elements + disperses material in space

Death of a Star

White dwarf

$0.8\,M_\odot < M_{star} < 1.4\,M_\odot$



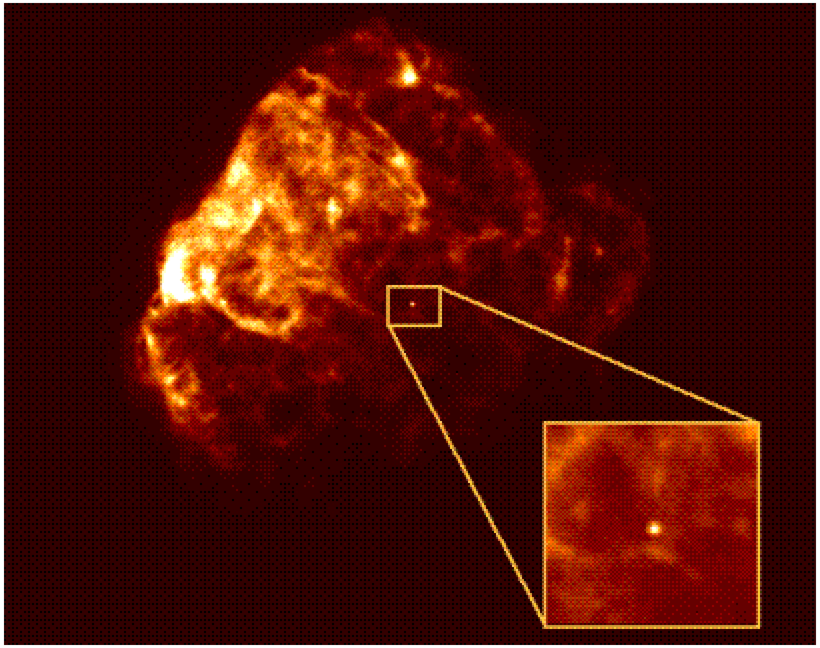
Star runs out of
fusion fuel at
temp reached
+ slowly cools

gravity "wins" – held up by
electron degeneracy
pressure

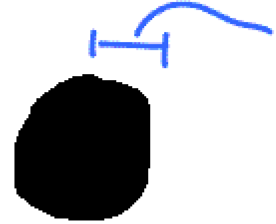
Neutron Star

$1.4\,M_\odot < M_{star} \lesssim 2.5\,M_\odot$

held up by
neutron degeneracy
pressure



Black hole



$M_{star} \gtrsim 2.5\, M_\odot$

gravitation so strong that even light cannot escape

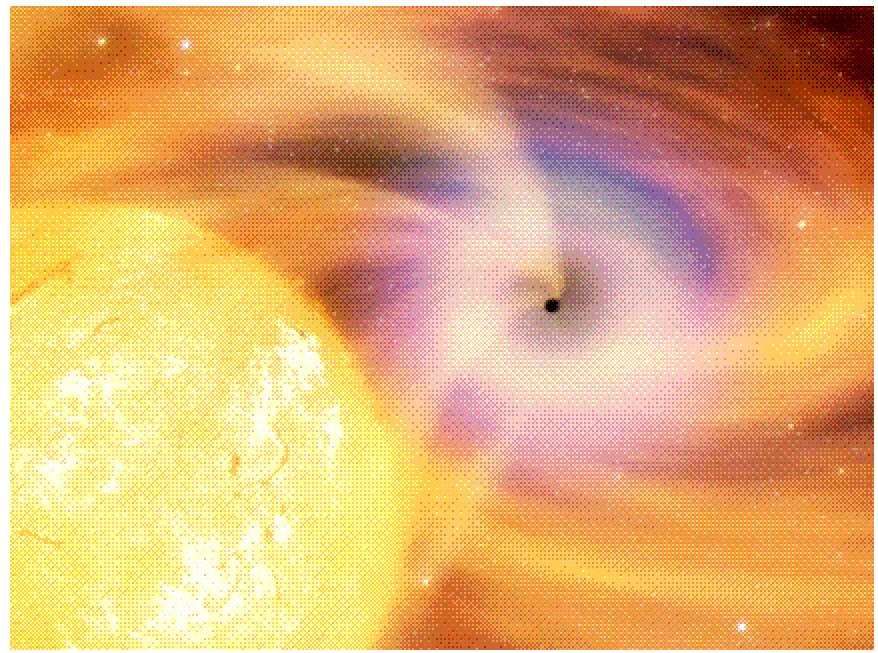


photo from http://orbitingfrog.com/blog/2008/07/10/can-light-orbit-a-black-hole/

Time appears to stop at event horizon (to outside observer)

Tidal effects ... Not a trip you want to take