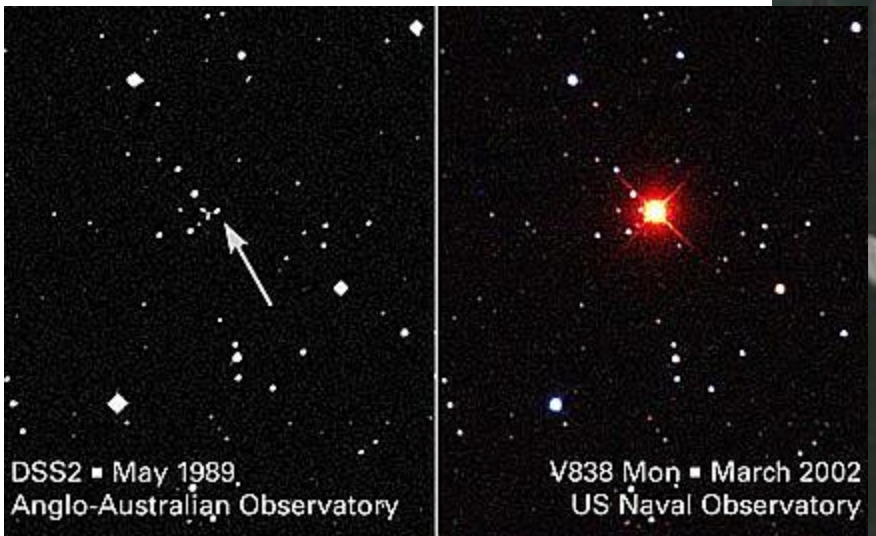
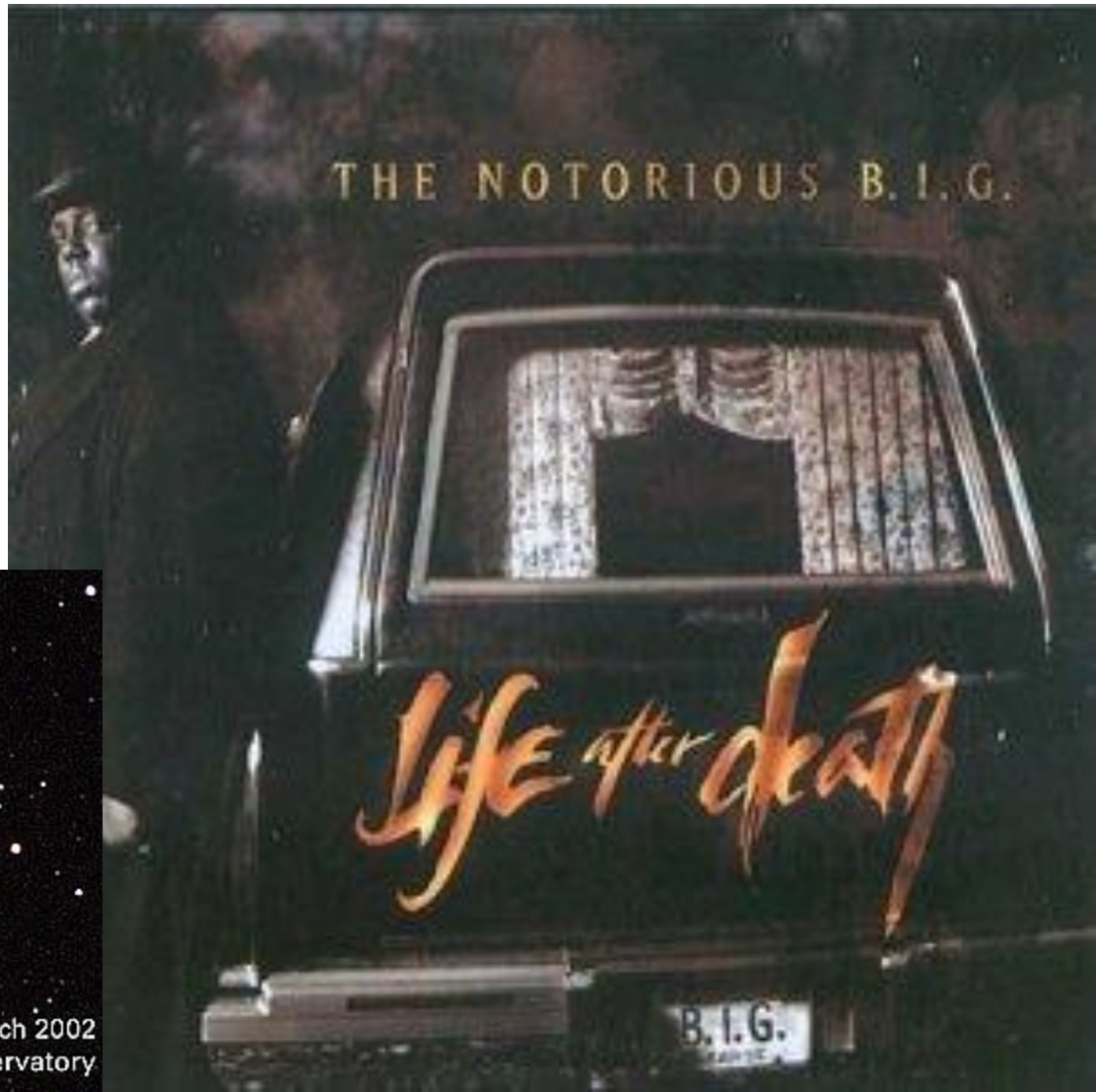
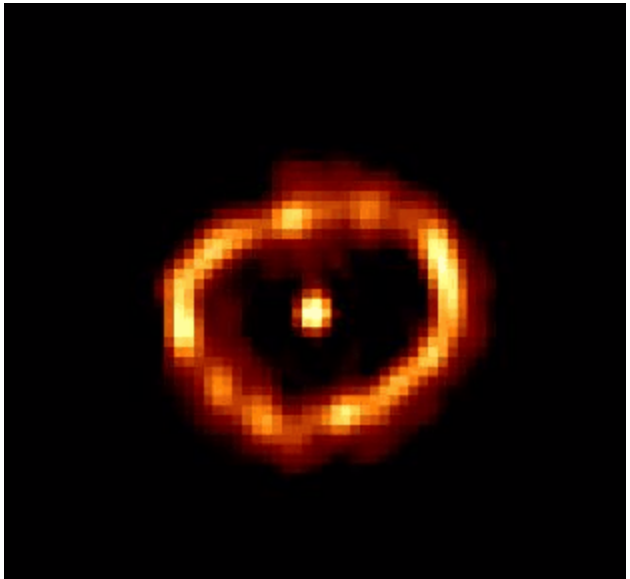
Ch 21 Explosions

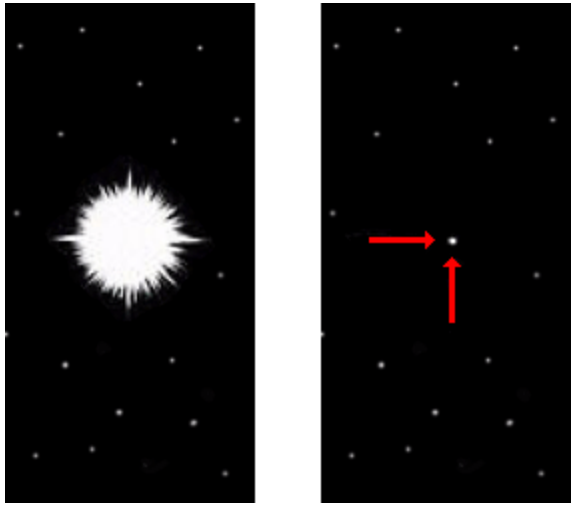
- Life after death?





- A white dwarf can come out of retirement if its companion donates enough matter
- This can cause a burst of fusion: a “Nova”
- This can repeat over and over





The Star that went boom

One night after departing from my beach hut in Bora-Bora, I looked up at the sky and noticed that I could see the Sun, or what looked to be a very bright Sun. Then it hit me: it was past midnight; the sun shouldn’t come up for another couple hours. I looked up the shoreline and saw a group of people gathering to gaze at the spectacle. After I joined them I learned that, via a news report from the Philippines, the local astronomers had discovered a nearby star that went supernova. Having taken an Astronomy course in grade 12, and written a short story on a supernova I know quite a bit on the subject (if I remember correctly I had gotten a great mark on that story.) After being assured that the explosion was distant enough to be little more than a “stellar” light show, I strolled on back to my hut where there was a hammock with my name on it (seriously I had it embroidered so nobody would get confused.)

-Eli McDonell

Blue Giant: an autobiography

Forming from an ultra-rich nebula, I guess you could say I was born with a silver spoon in my mouth, with a birth weight of 8 solar masses, 6 oz. Just like Jimi Hendrix, 2Pac, and Jonah Lomu, I “died” at a young age of 25 million years, but not before a huge supernova party that blasted heavy metals throughout the cosmos. I’m now retired, in hiding as a black hole. Nobody can see me, so they’ll never find my secret!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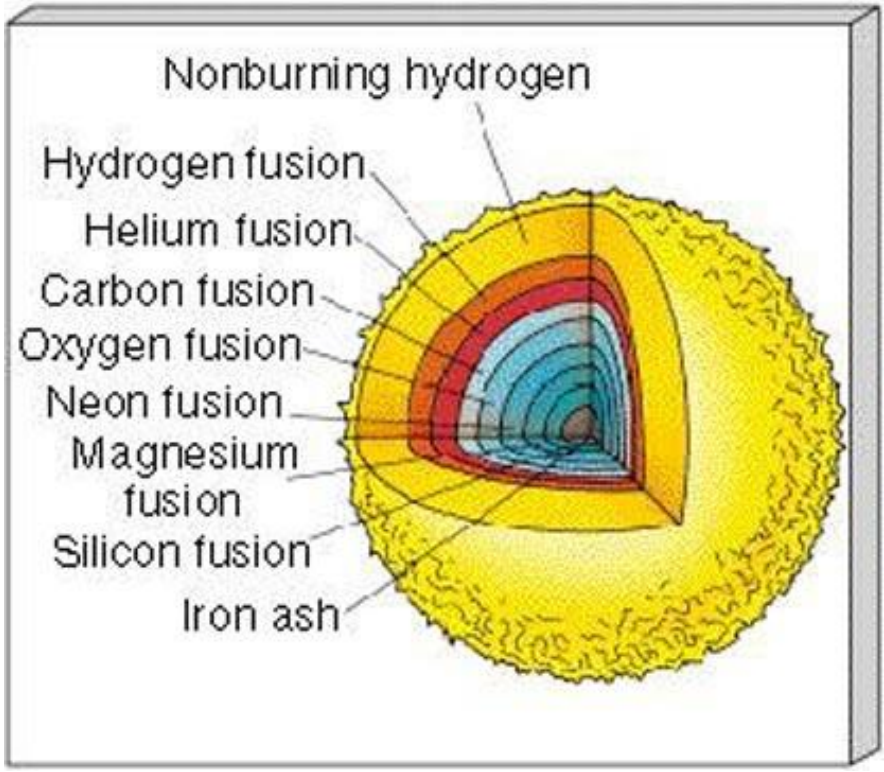
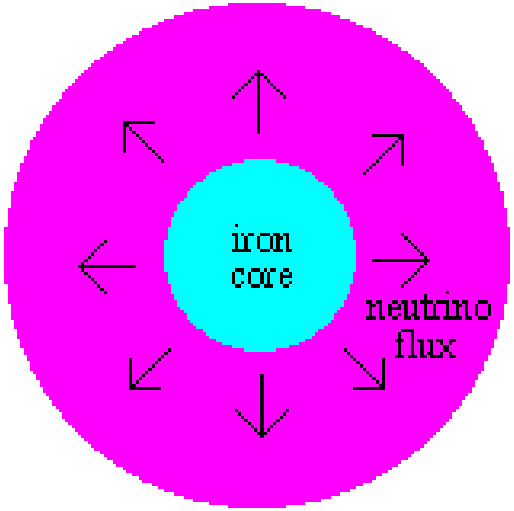
Fusion Progression

- Once the core reaches iron we get:
  - Overheating
  - Photodisintegration
  - Neutronization
  - Degeneracy “bounce”



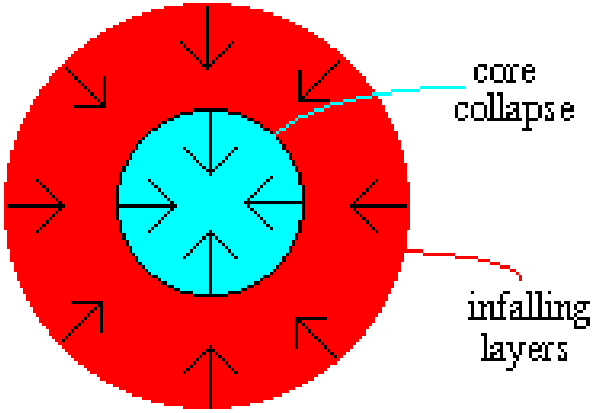
Supernova Explosion

Inert iron core stops producing energy, but continues to produce neutrinos which release energy from core



Densities climb, protons and electrons combine to produce neutrons and more neutrinos

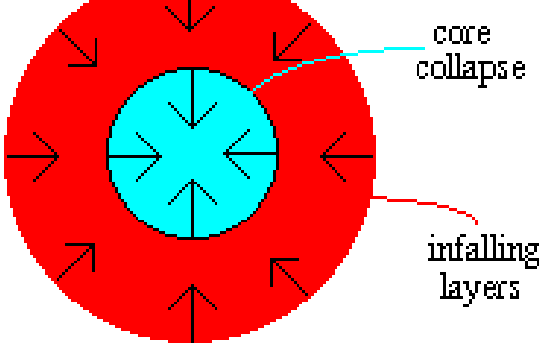
Sudden lost of energy causes core to collapse from lack of pressure support



Regions around core are unsupported and plunge onto core at speeds up to 15% the speed of light

Neutron densities are so high in core that it is incompressible and rigid. Infalling layers strike core and rebound.

Regions around core are unsupported and plunge onto core at speeds up to 15% the speed of light

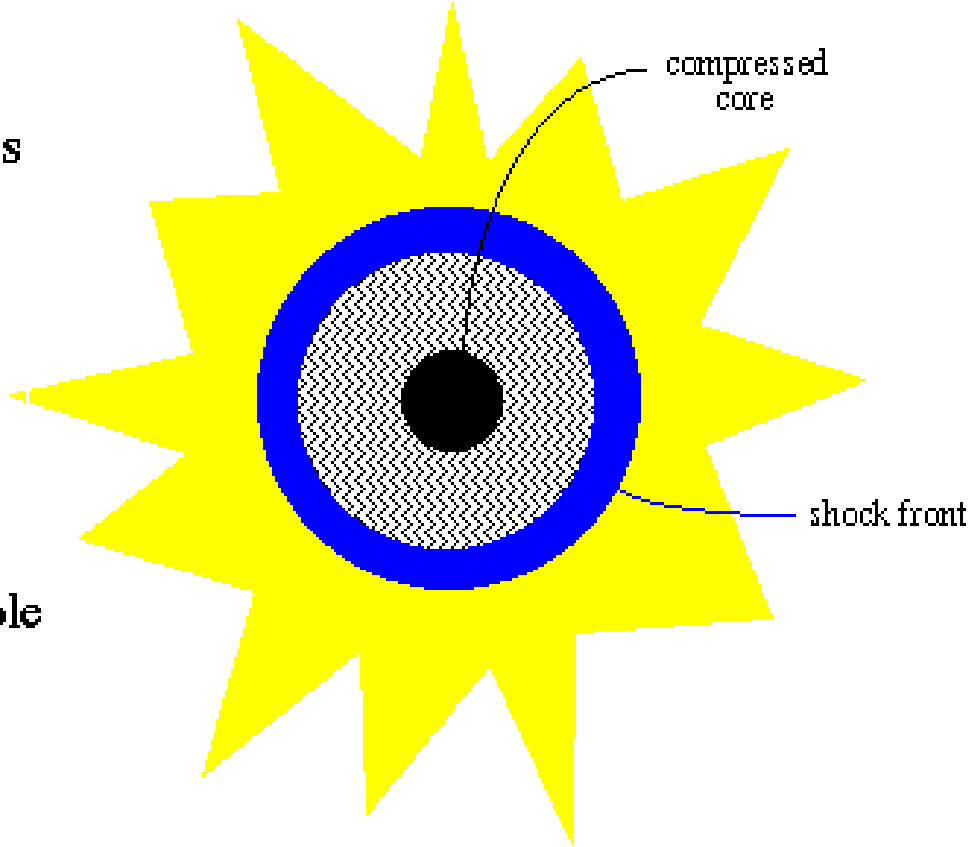


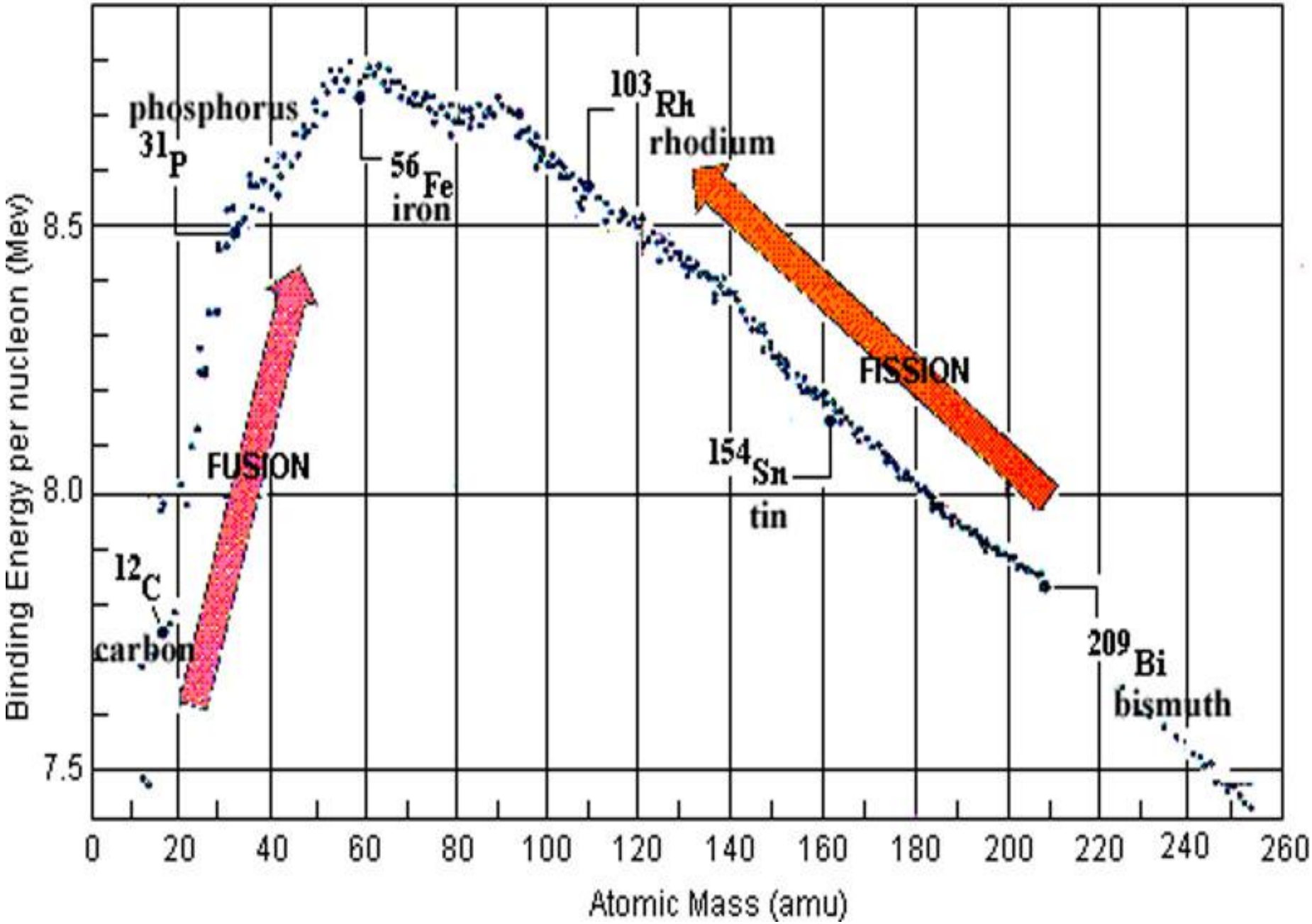
Neutron densities are so high in core that it is incompressible and rigid. Infalling layers strike core and rebound.

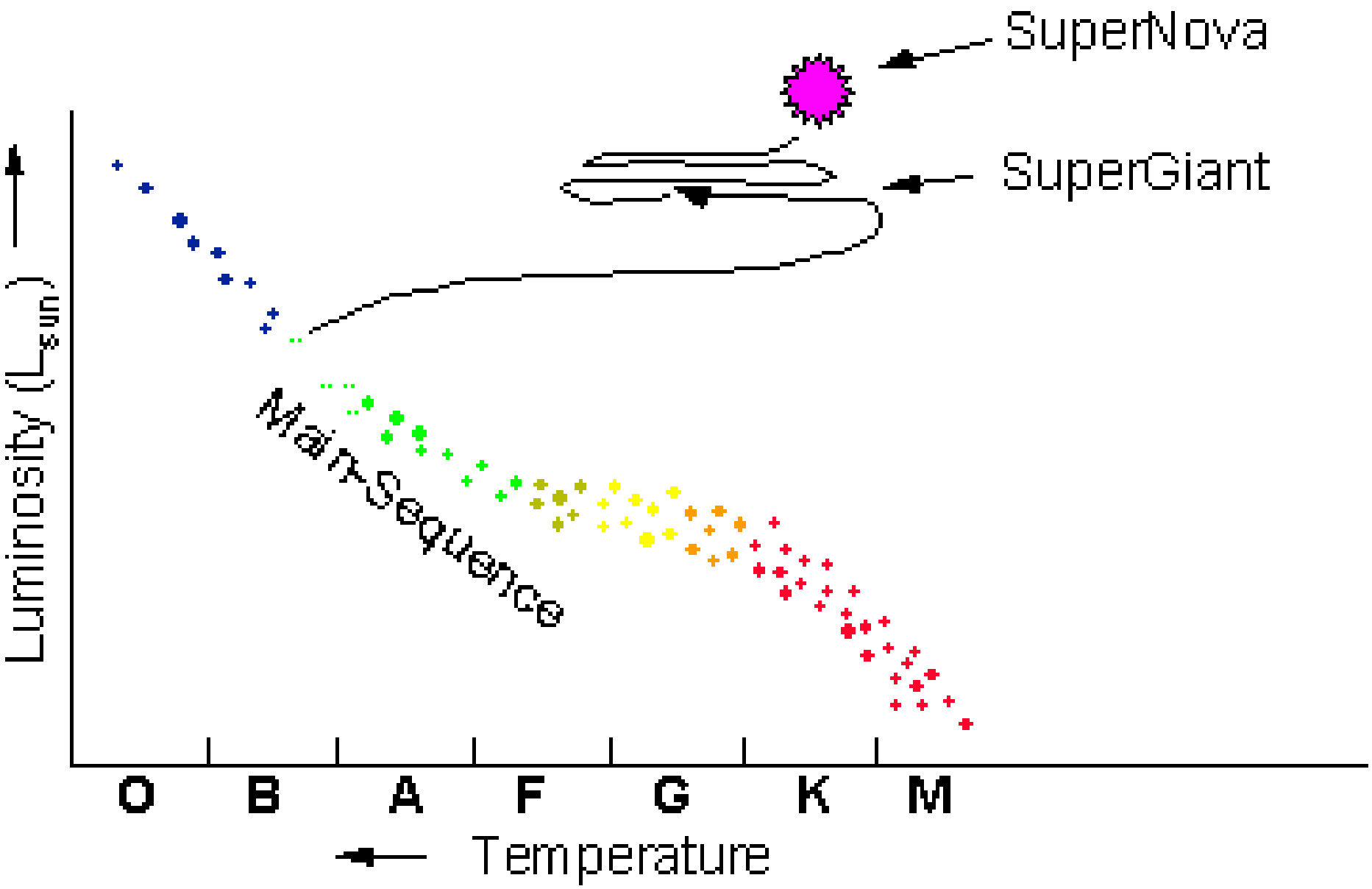
In a fraction of a second, a wave of matter forms a shock front and moves outward towards stellar surface.

Shock wave hits surface of star and explodes

Inward shock compresses remaining stellar core into neutron star or black hole



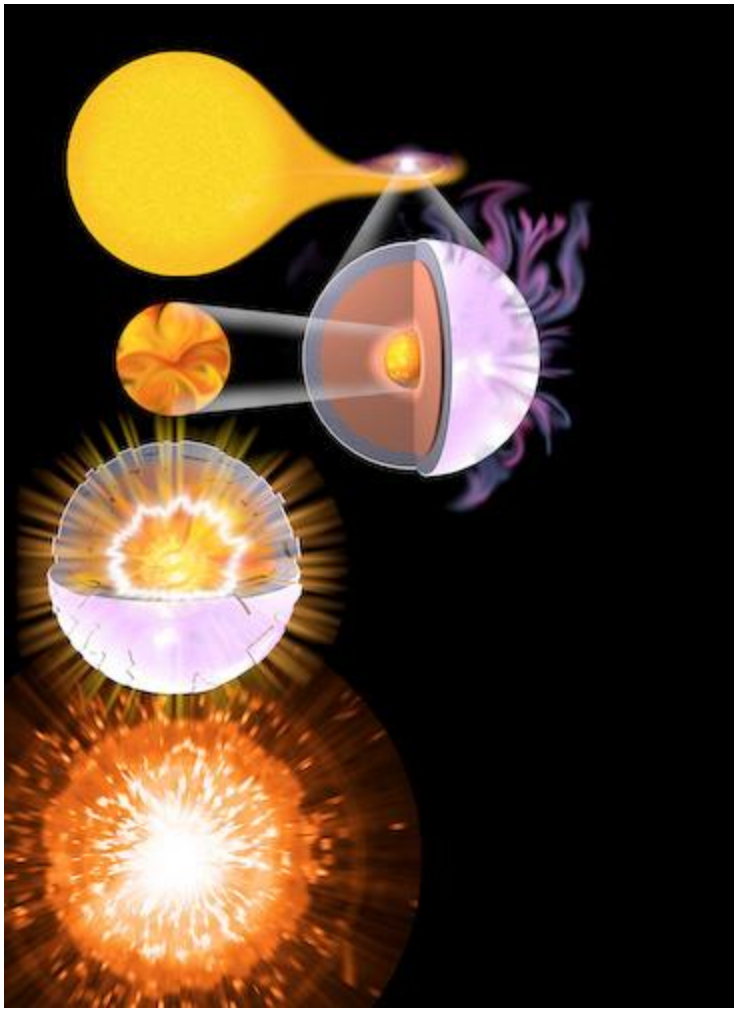

phosphorus
31P
56Fe
iron
103Rh
rhodium
FISSION
FUSION
154Sn
tin
12C
carbon
209Bi
bismuth
Binding Energy per nucleon (Mev)
8.5
8.0
7.5
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Atomic Mass (amu)


SuperNova
SuperGiant
Main Sequence
Luminosity (L_{sun})
O
B
A
F
G
K
M
Temperature

- Choose 5 Vocab p. 562-3
- Start R&D #1-10 p. 563

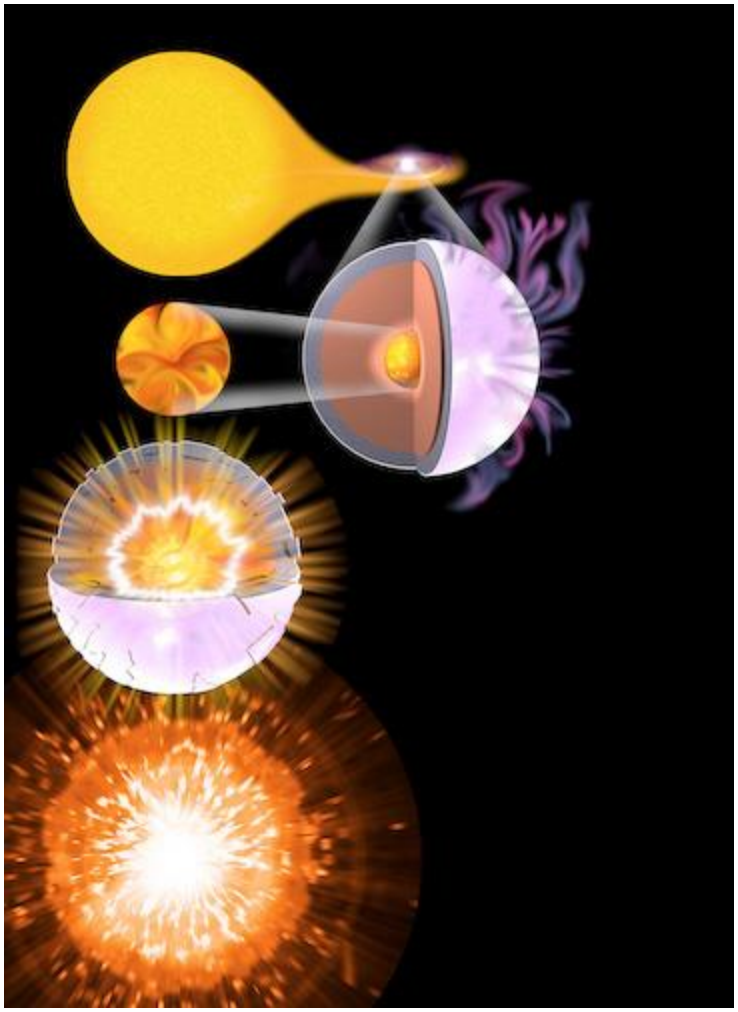
Type I Supernova

- A massive White dwarf might be just below the threshold of degeneracy
- Enough mass is donated to push it over the edge



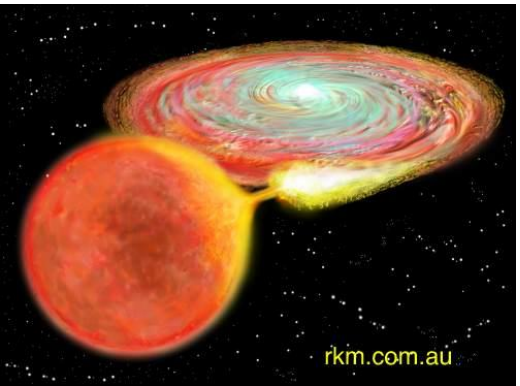
Standard Candle!

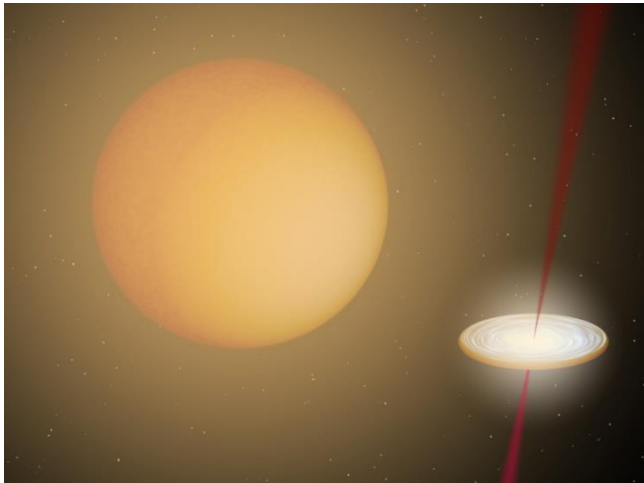
- Type Ia supernova: our best standard candle!
- Highest rung on the distance ladder!



Type I Supernova

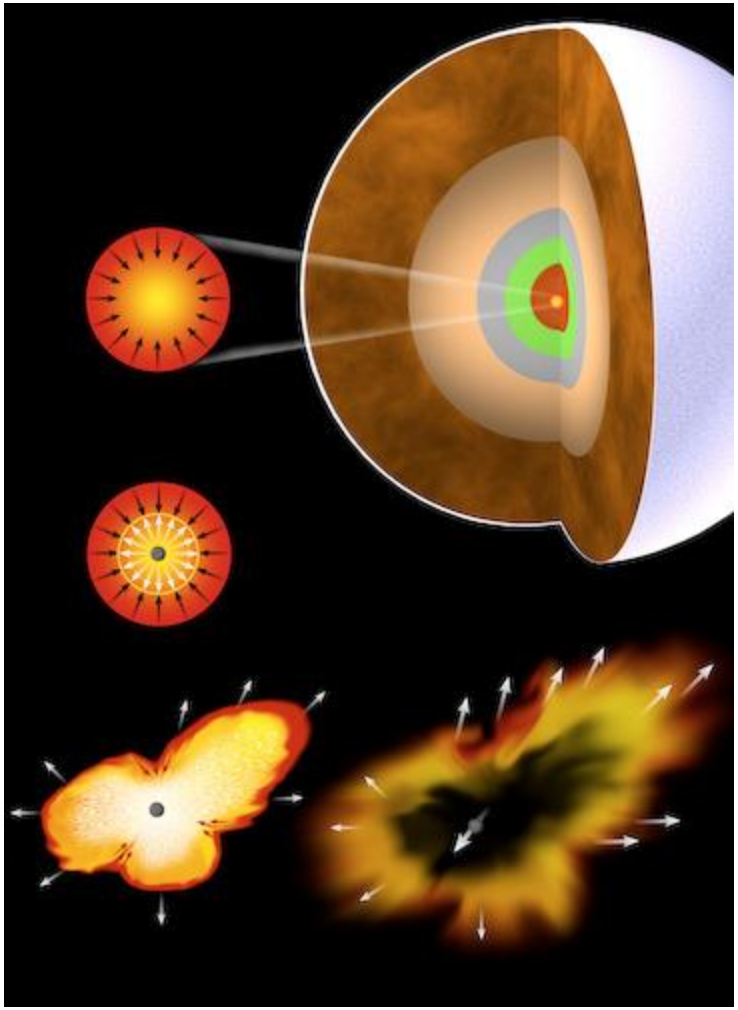
- If the White Dwarf's mass gets high enough, it collapses
  - over 1.4 solar masses, known as the Chandrasekhar mass
- Carbon fusion begins, and the star explodes violently: Type I supernova





Type II Supernova

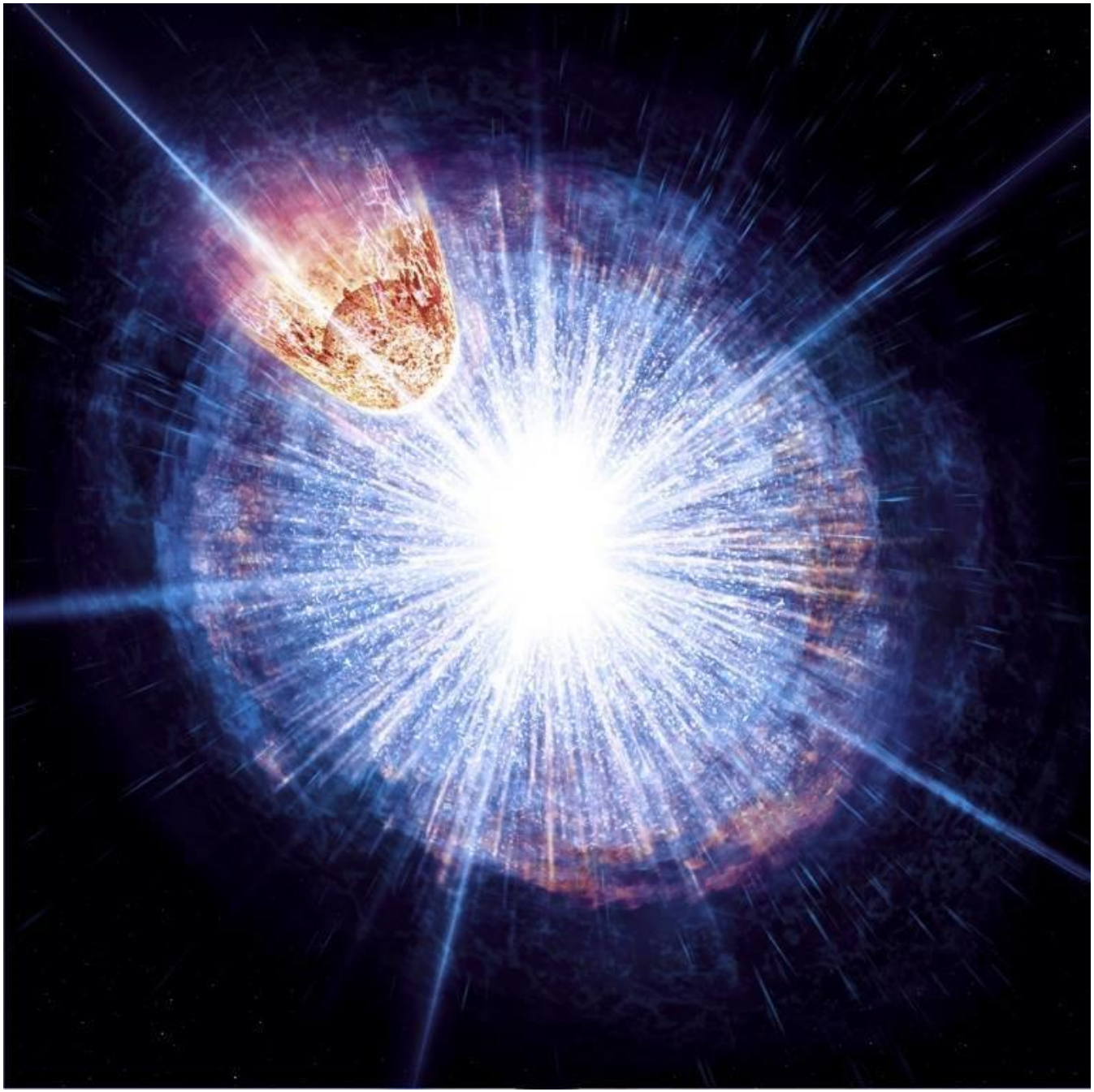
- A very high mass star continues fusion to an iron core
- The core progresses straight to degeneracy



Type II Supernova

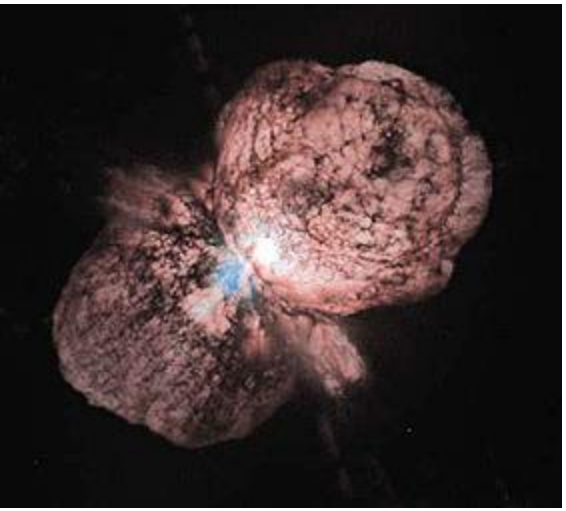
- A Type II supernova happens when a very high mass star when it has continued fusion until its core is pure iron
- It is no longer able to produce energy from fusion and its core collapses
- The atoms are reduced to degenerate matter, vastly increasing density and producing a neutrino burst

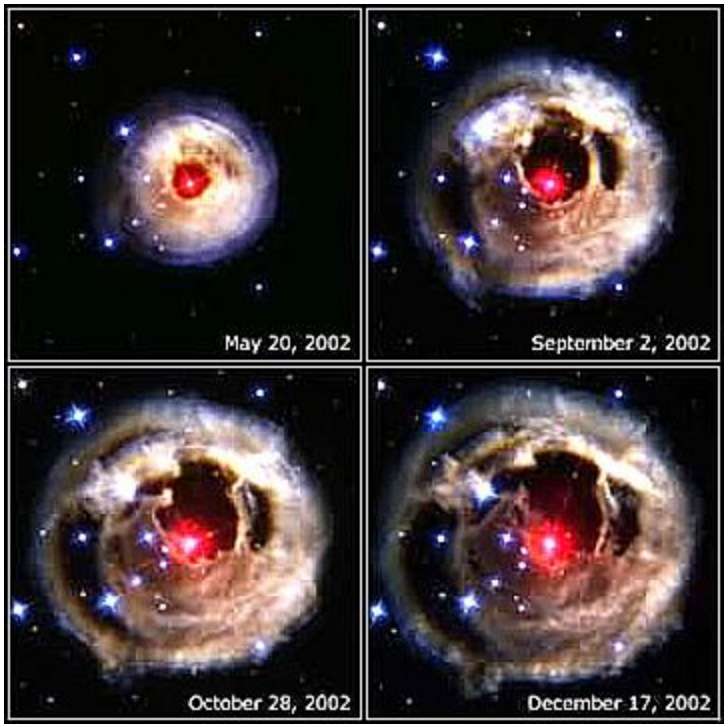
- Both types give off billions of times more energy than the Sun for days to months

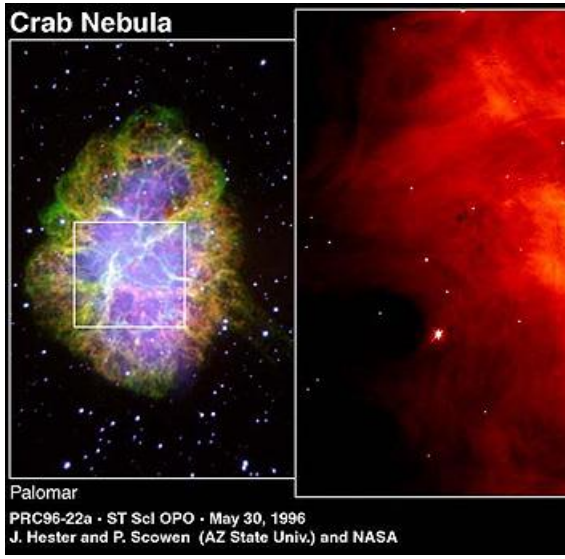


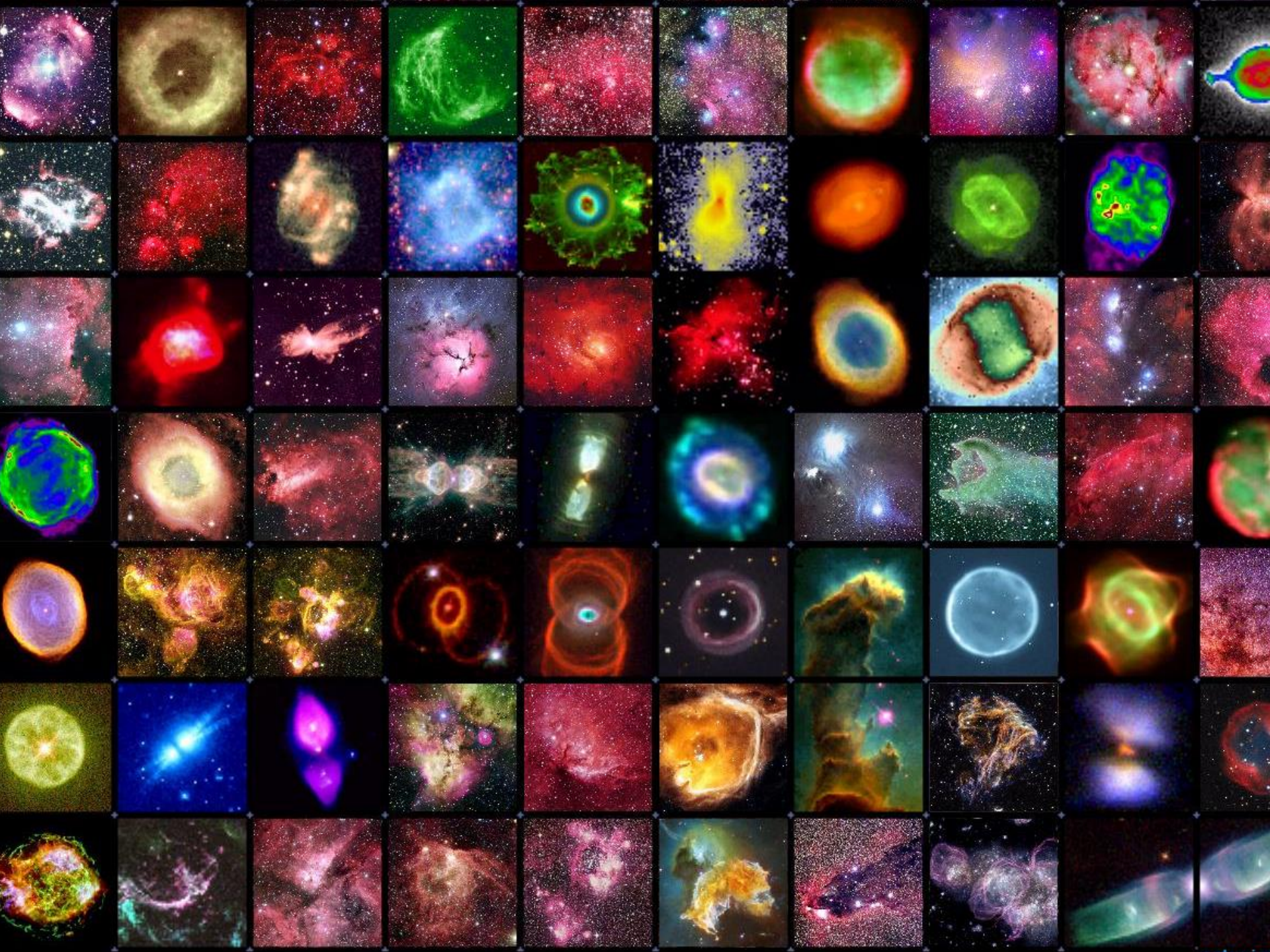
Supernova Remnants

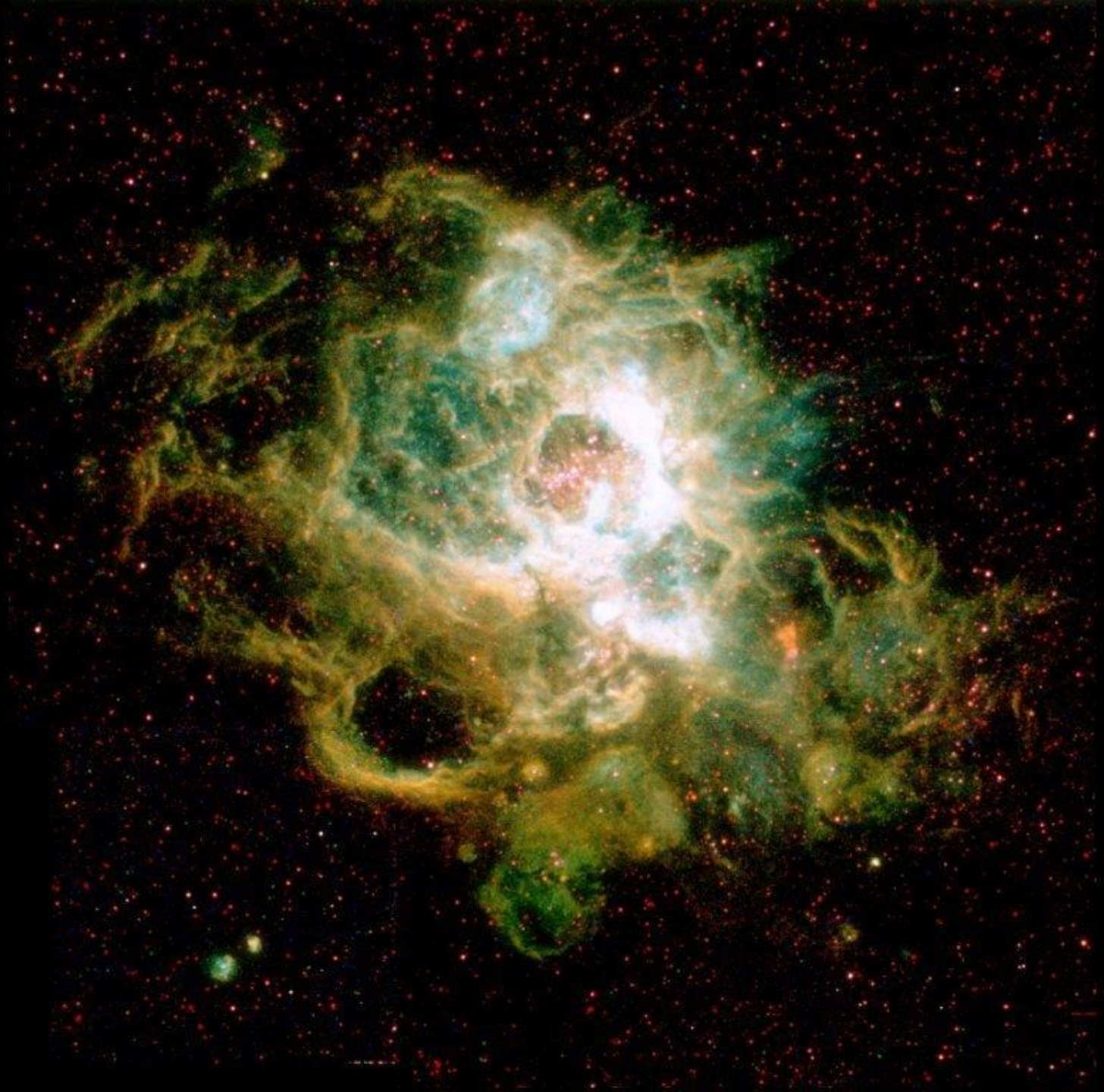
- Witnessing a supernova is rare (phew!)
- We can see the remnants for long after





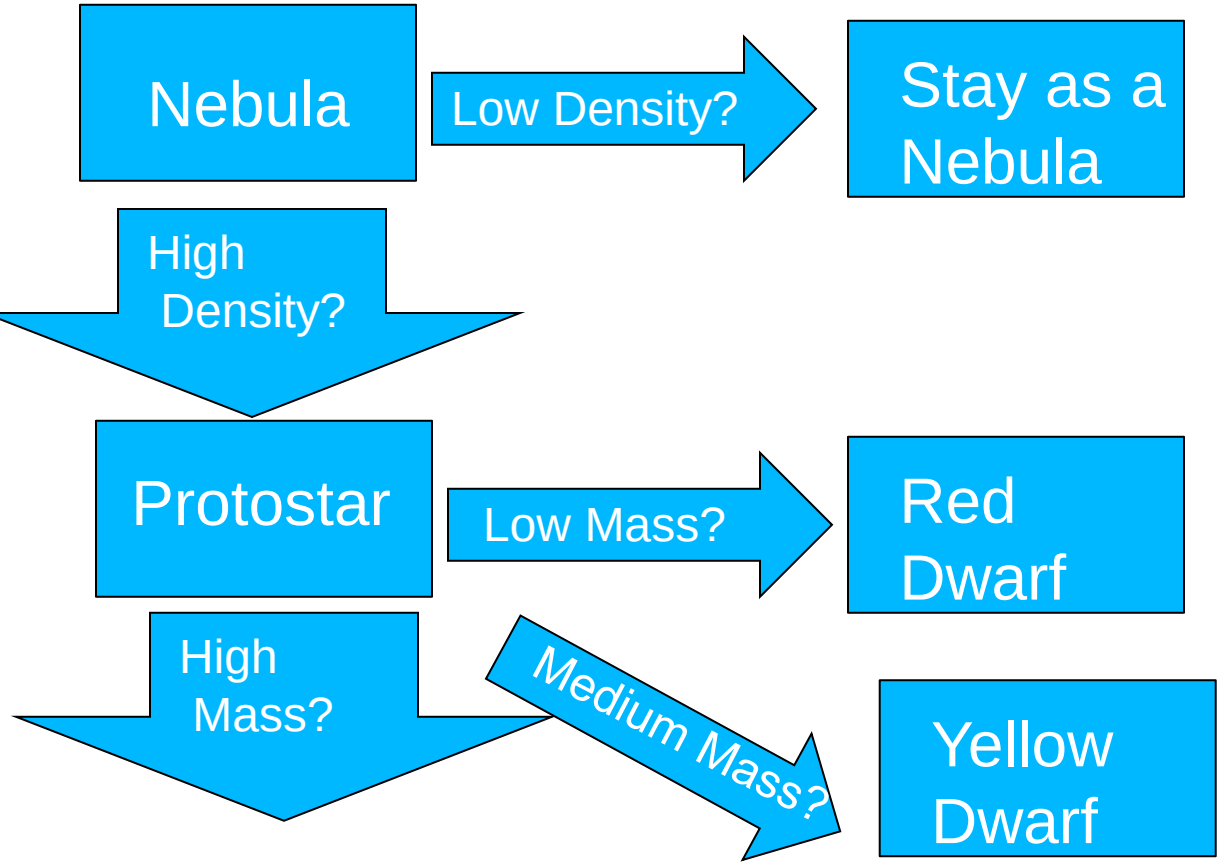


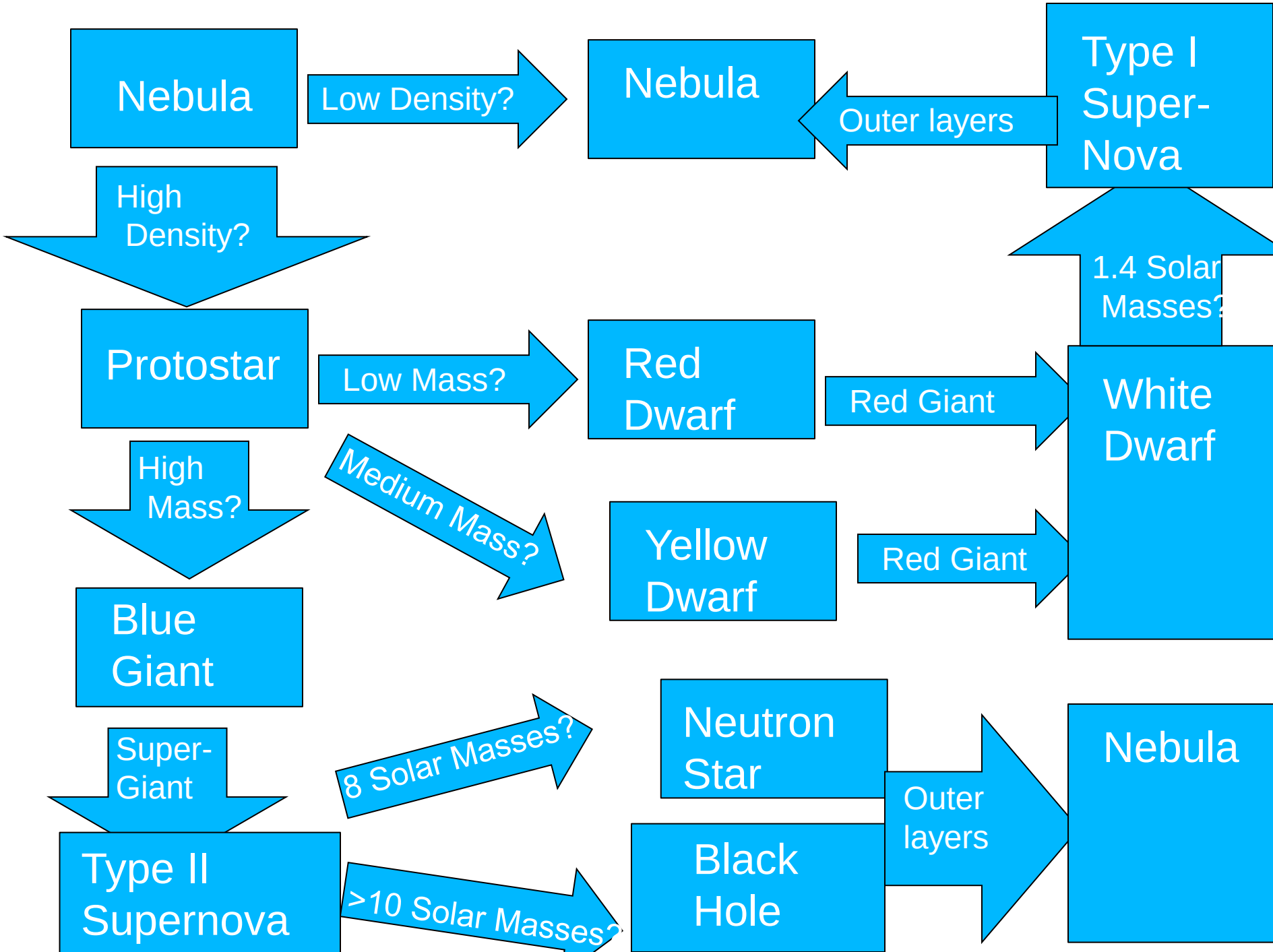


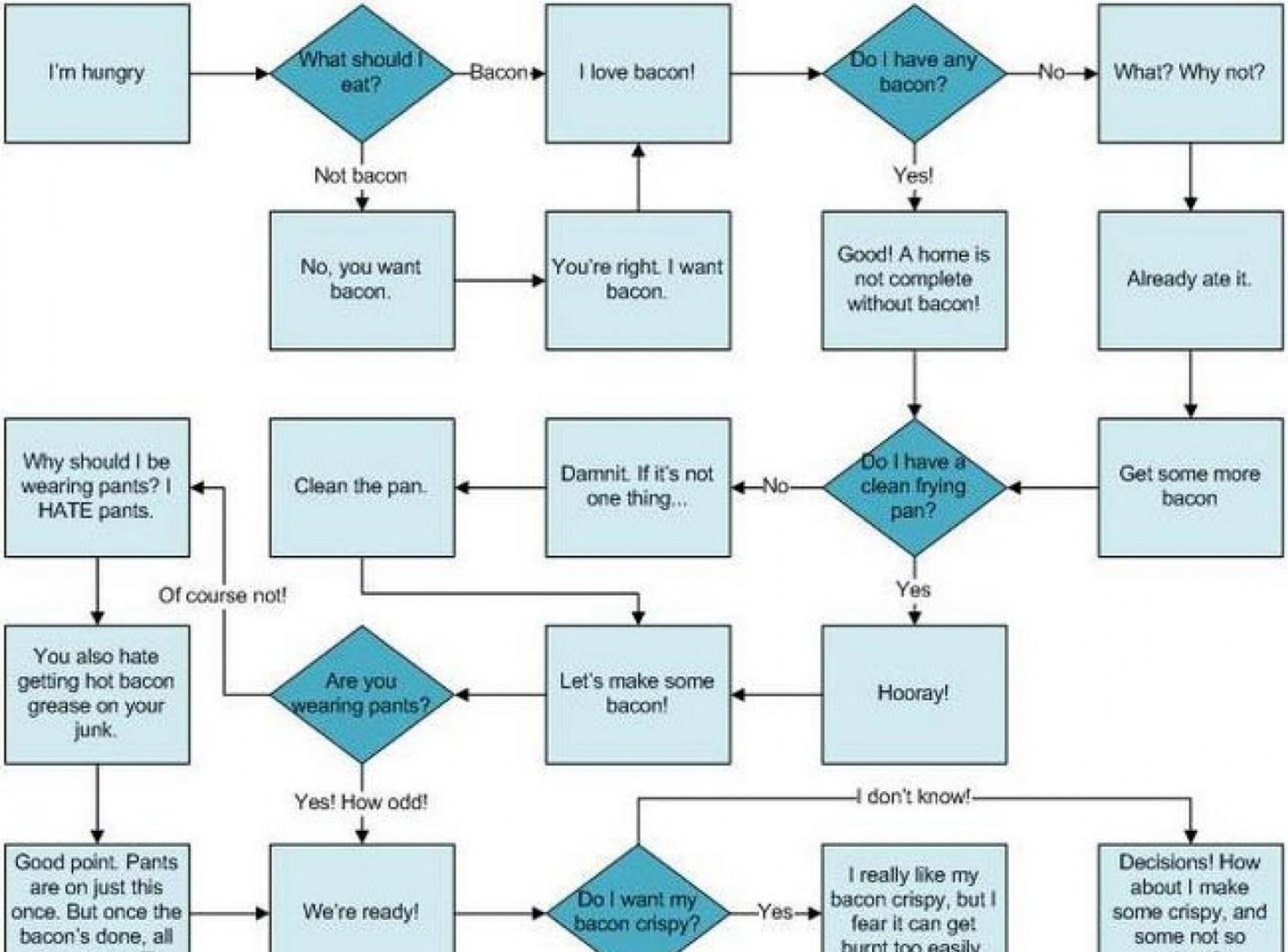


Make a flowchart

Include each phase of a star's life cycle, and about how much mass is necessary for each branch




Nebula
Low Density?
Nebula
Outer layers
Type I Super-Nova
High Density?
1.4 Solar Masses?
Protostar
Low Mass?
Red Dwarf
Red Giant
White Dwarf
High Mass?
Medium Mass?
Yellow Dwarf
Red Giant
Blue Giant
Neutron Star
Super-Giant
8 Solar Masses?
Nebula
Outer layers
Type II Supernova
>10 Solar Masses?
Black Hole


I'm hungry
What should I eat?
Bacon
I love bacon!
Do I have any bacon?
No
What? Why not?
Not bacon
No, you want bacon.
You're right. I want bacon.
Yes!
Good! A home is not complete without bacon!
Already ate it.
Get some more bacon
Do I have a clean frying pan?
No
Damnit. If it's not one thing...
Clean the pan.
Why should I be wearing pants? I HATE pants.
Yes
Hooray!
Let's make some bacon!
Are you wearing pants?
Of course not!
You also hate getting hot bacon grease on your junk.
Yes! How odd!
I don't know!
Good point. Pants are on just this once. But once the bacon's done, all
We're ready!
Do I want my bacon crispy?
Yes
I really like my bacon crispy, but I fear it can get burnt too easily
Decisions! How about I make some crispy, and some not so