

The Death of Stars: Neutron Stars, Black Holes and Beyond



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Astronomy in the City
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Credit: NASA
SN 2006gy

Outline

- What is a star?
- The life of single stars (crash course)
- The death of stars: White Dwarfs, Neutron Stars and Black Holes
- Beyond: Pair-instability Supernova

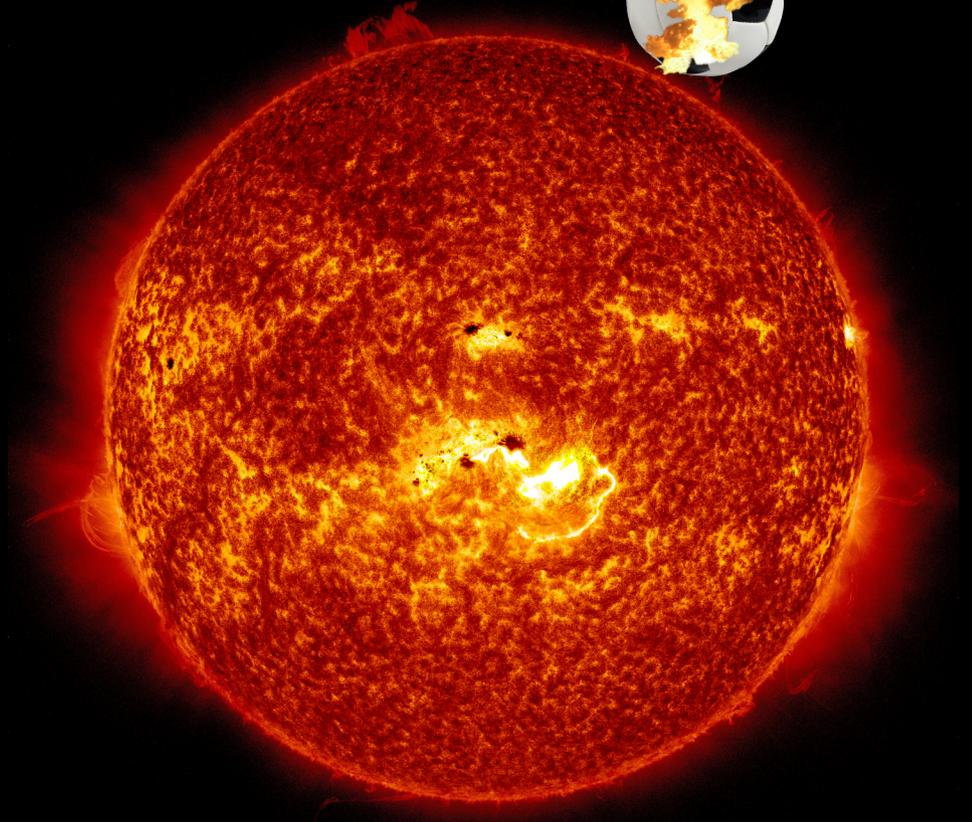


A star is a **luminous sphere**, which burns lighter elements into heavier elements and it is **held together by its own gravity**.

Self-gravitation: matter pushes inwards



Earth
Mass: 6×10^{24} kg



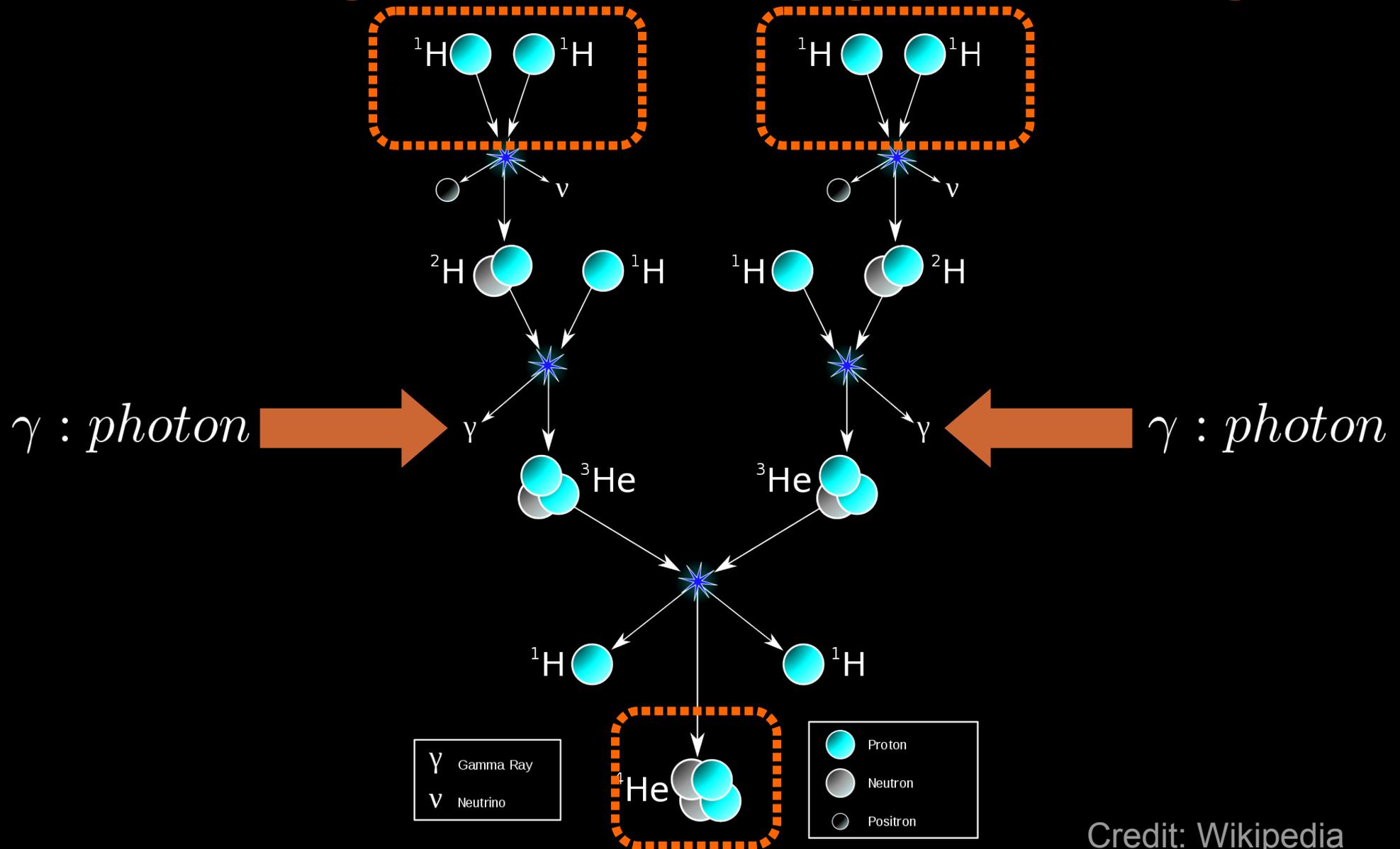
Sun
Mass: 2×10^{30} kg

$10^{24} = 1000000000000000000000000$

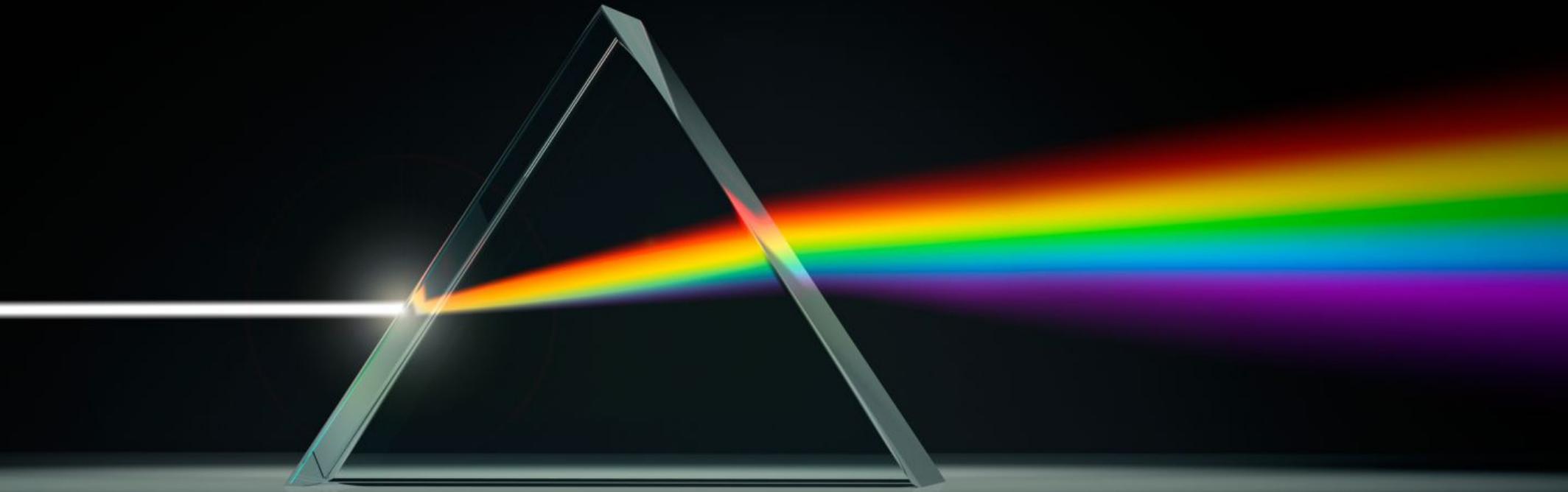
$10^{30} = 1000000000000000000000000000000$



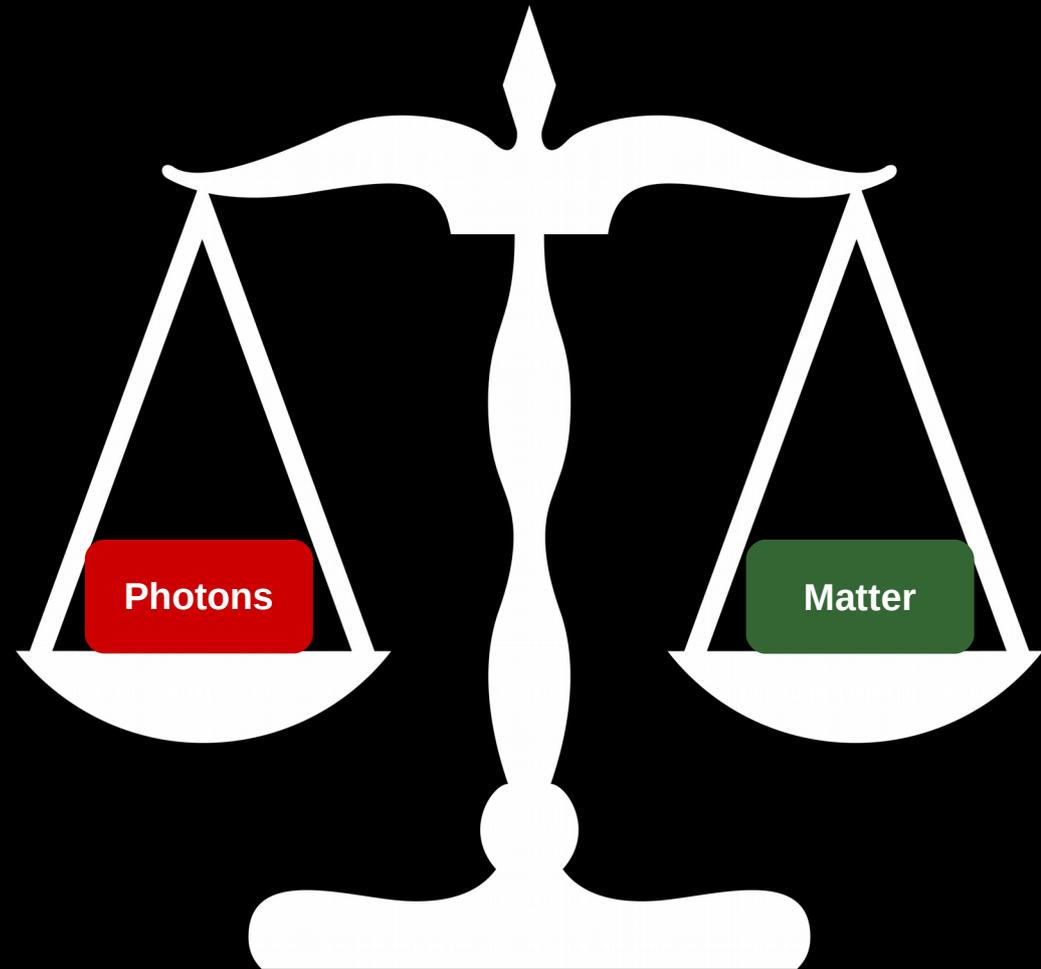
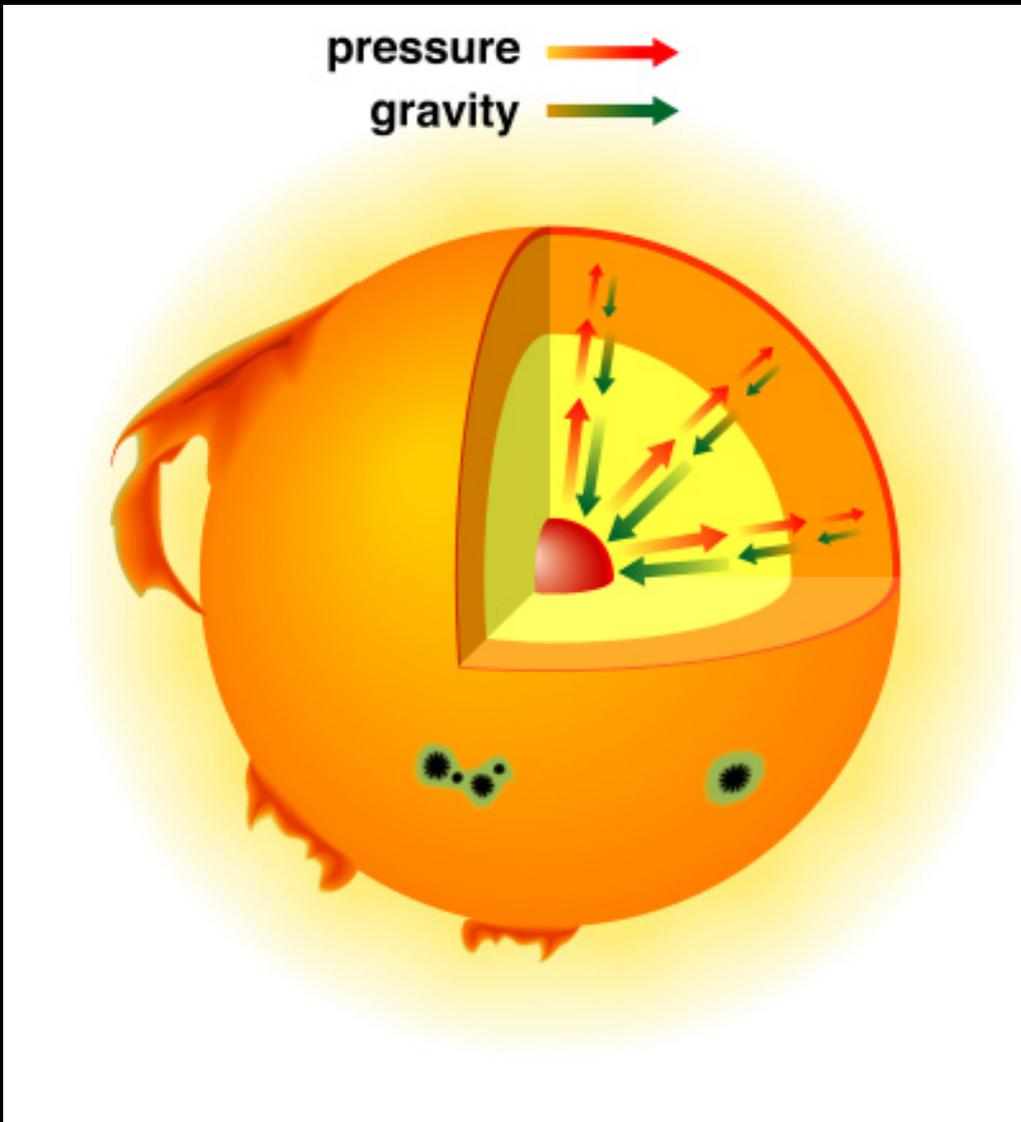
Nuclear Burning: a star gets hot and begins burning



Photons (γ), are massless particles which form light.
They travel at the speed of light in vacuum and possess energy.

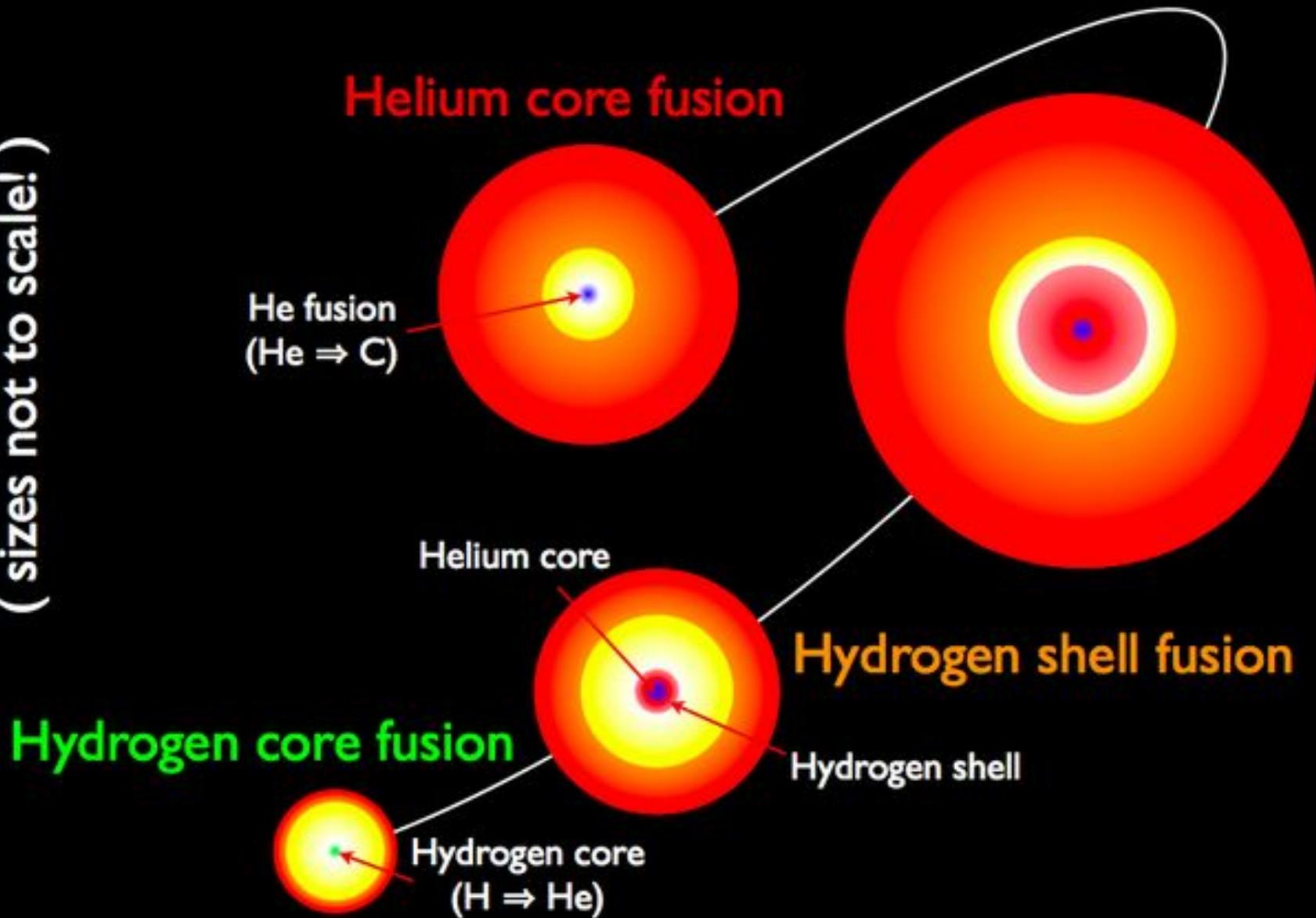


Hydrostatic Equilibrium

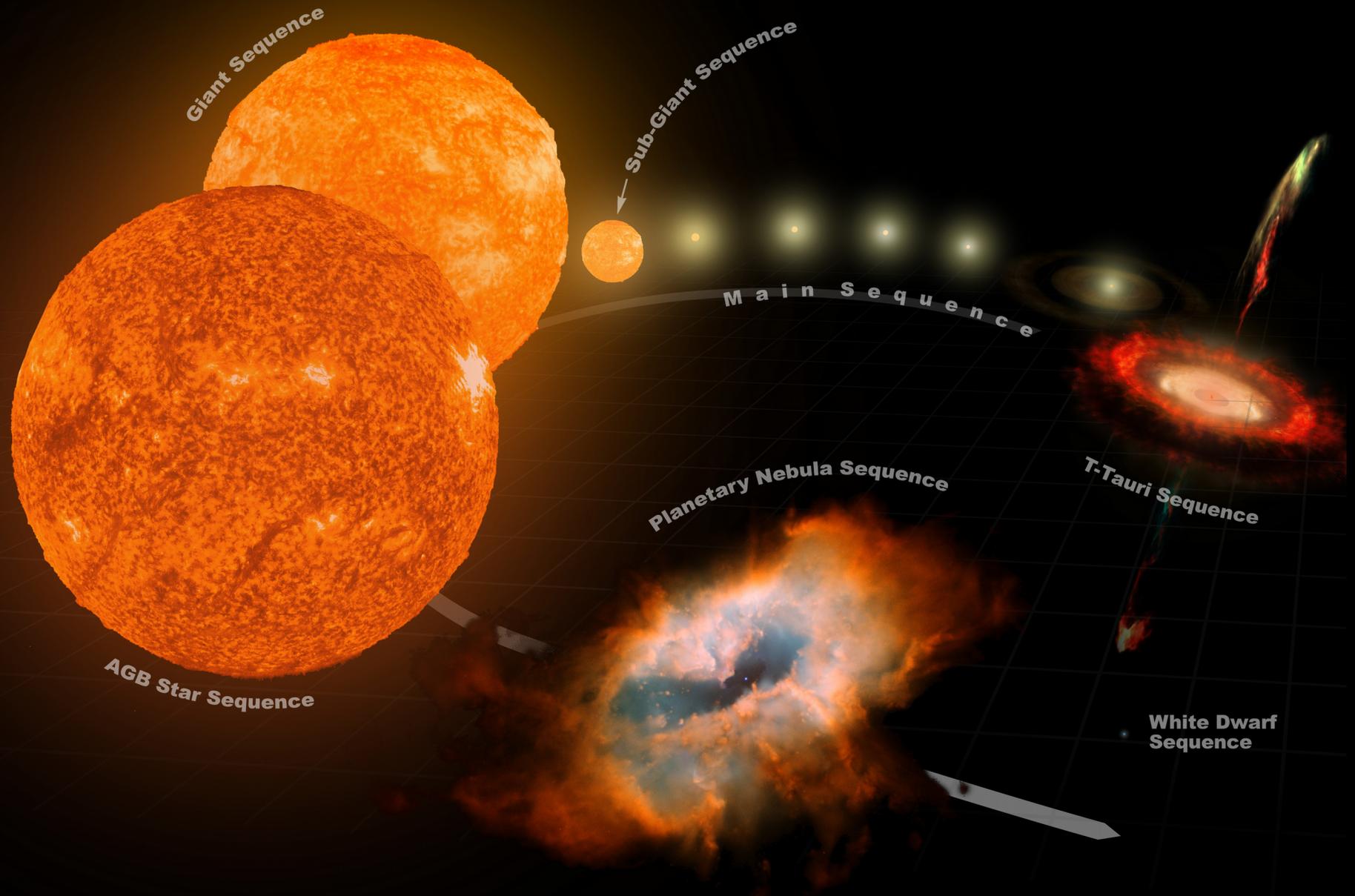


Stellar evolution

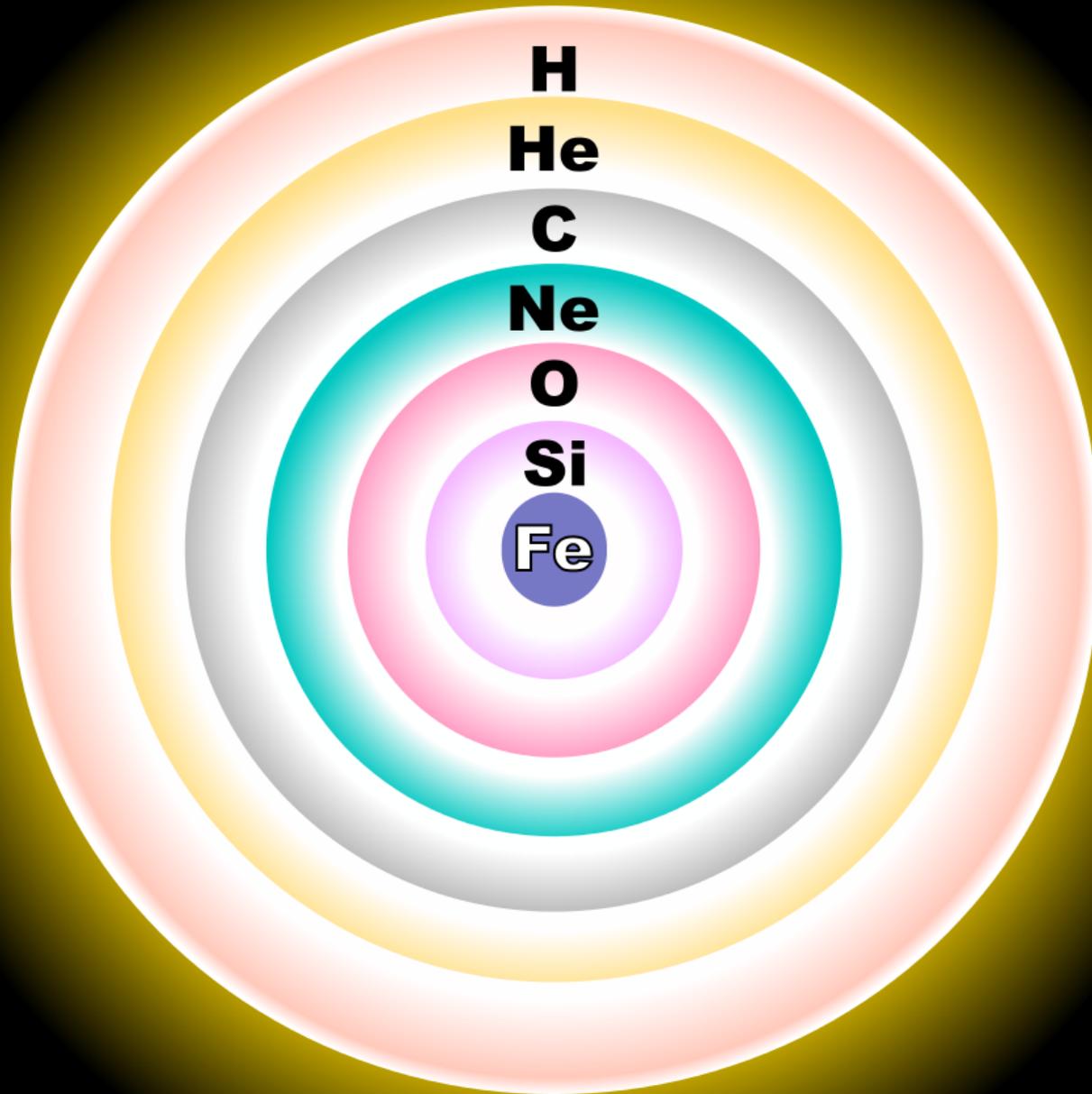
(sizes not to scale!)



Stellar Evolution (0.8 - 8 M_{\odot})

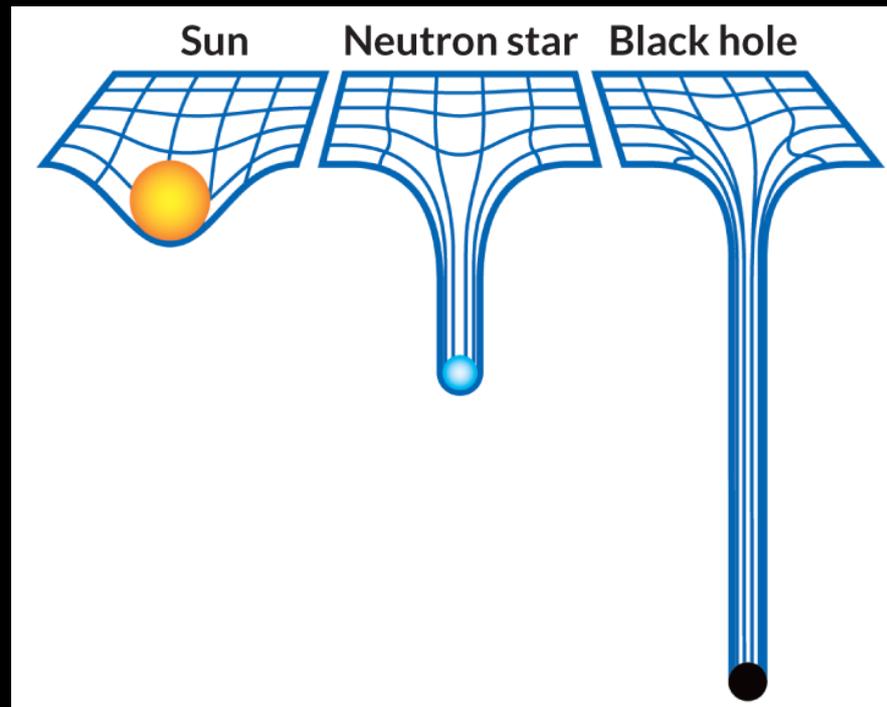
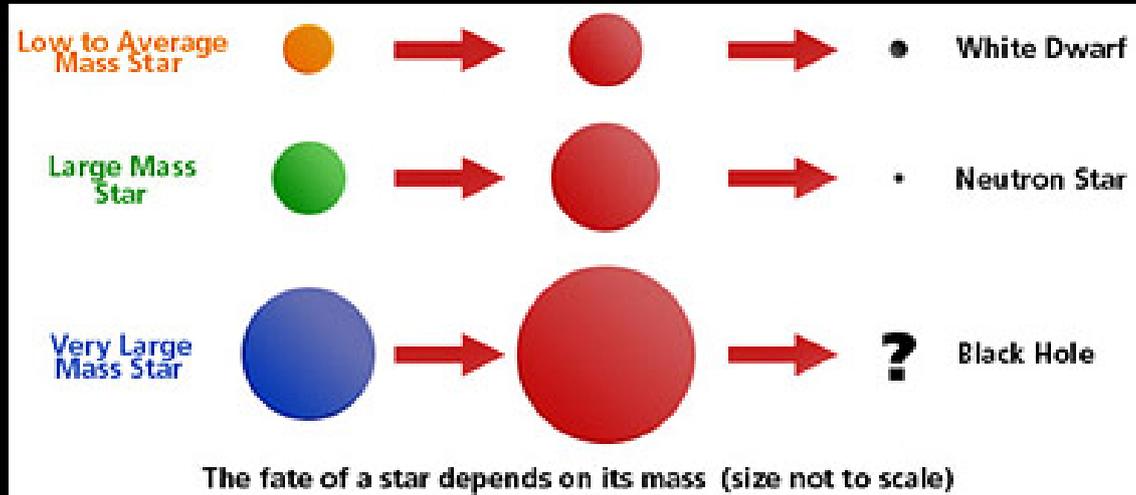


Credit: Wikipedia

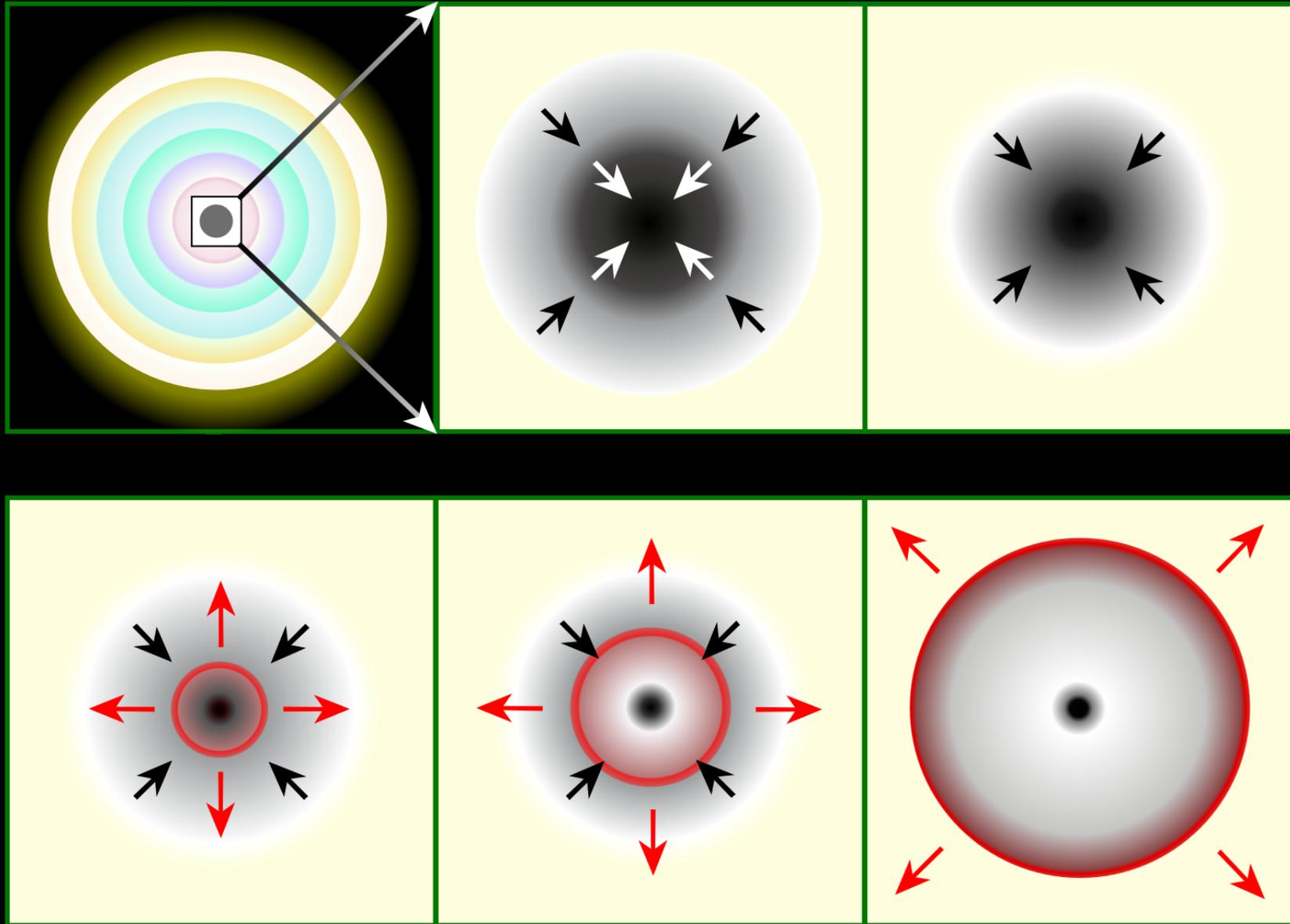


The Death of a Star:

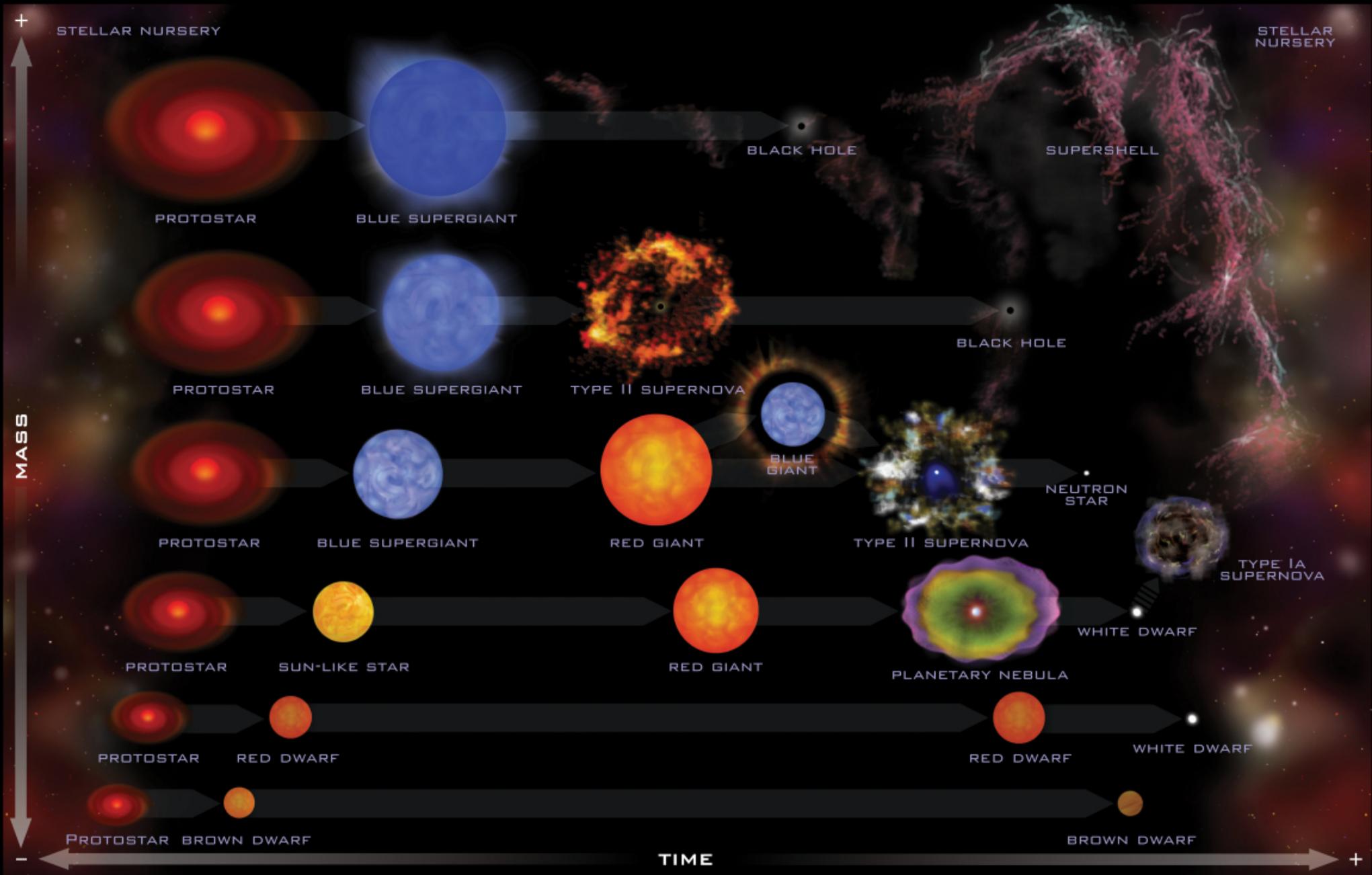
White Dwarf (WD), Neutron Stars (NS) and Black Holes (BH)



Supernovae: Neutron Stars and Black Holes



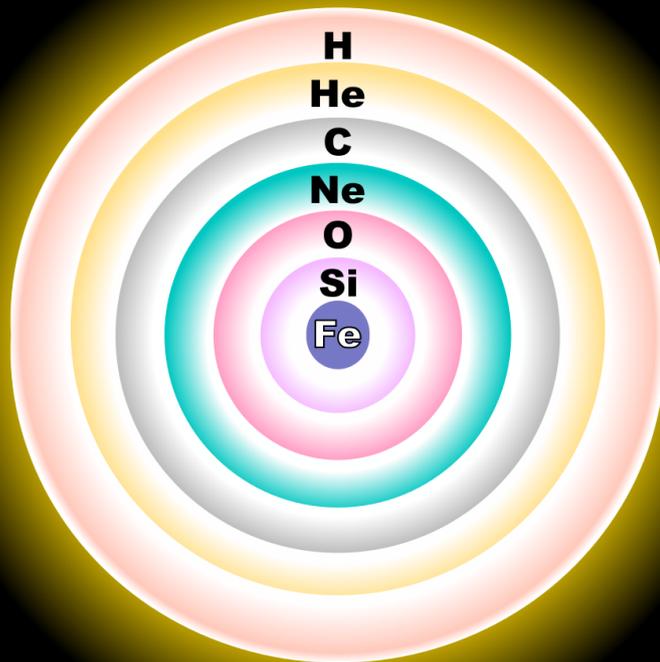
Credit: Wikipedia



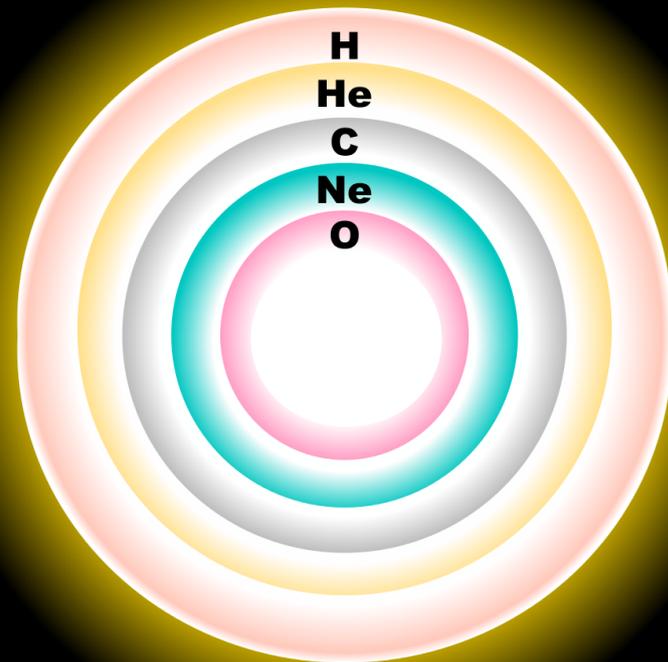
Credit: NASA

Beyond: Pair-instability Supernova

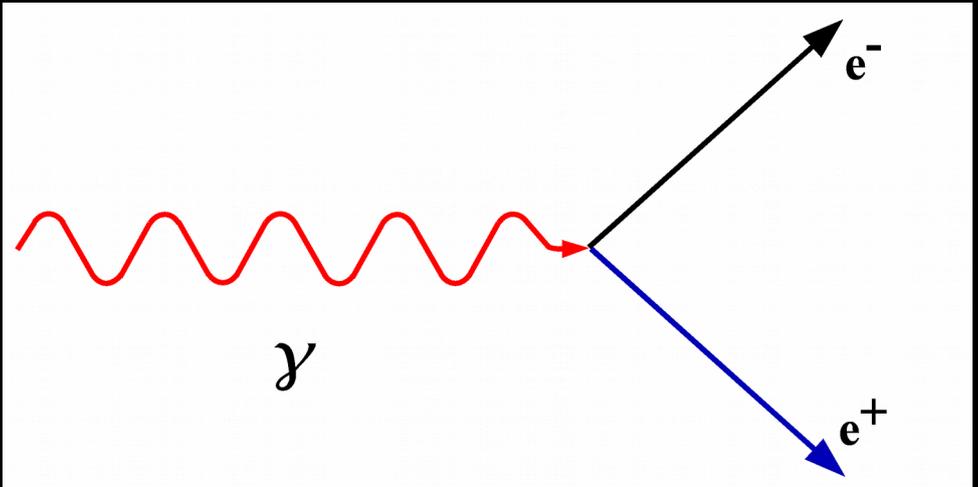
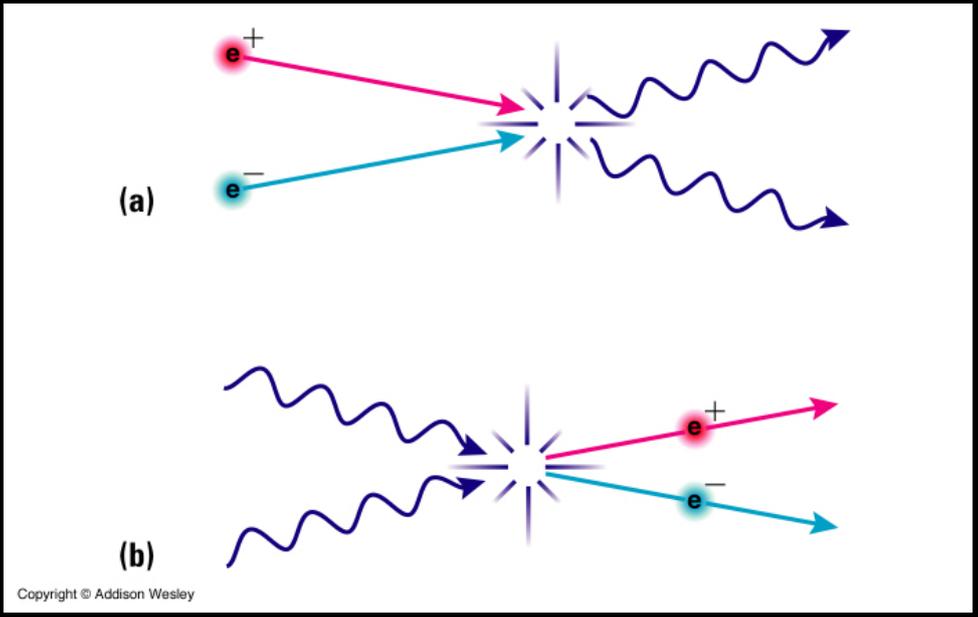
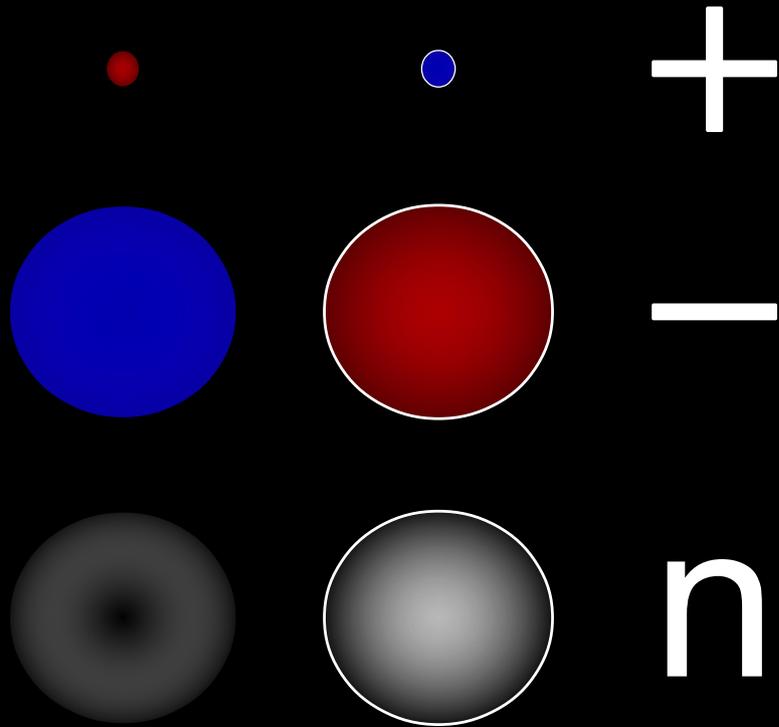
Core-collapse



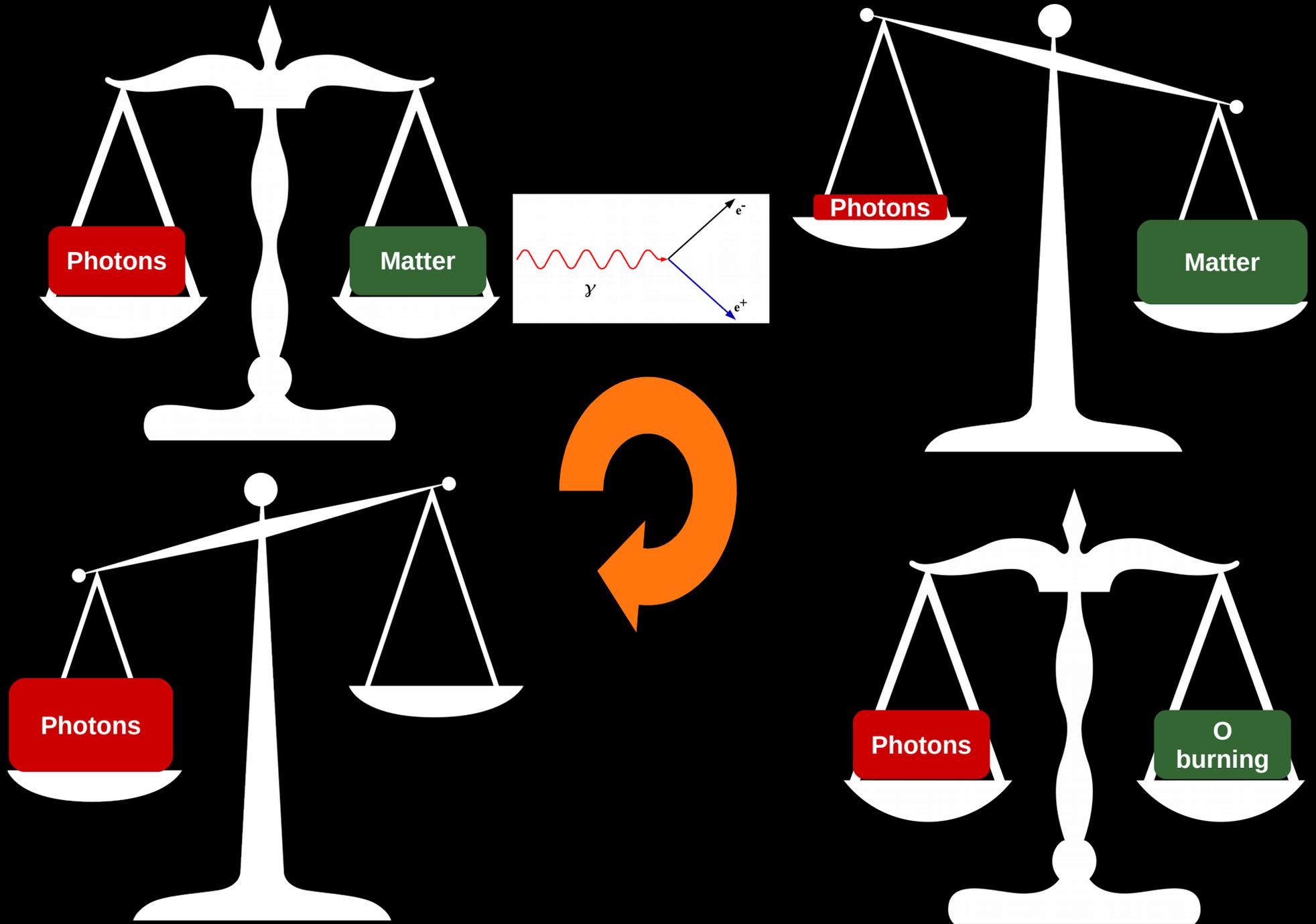
Pair-instability



Pair Production

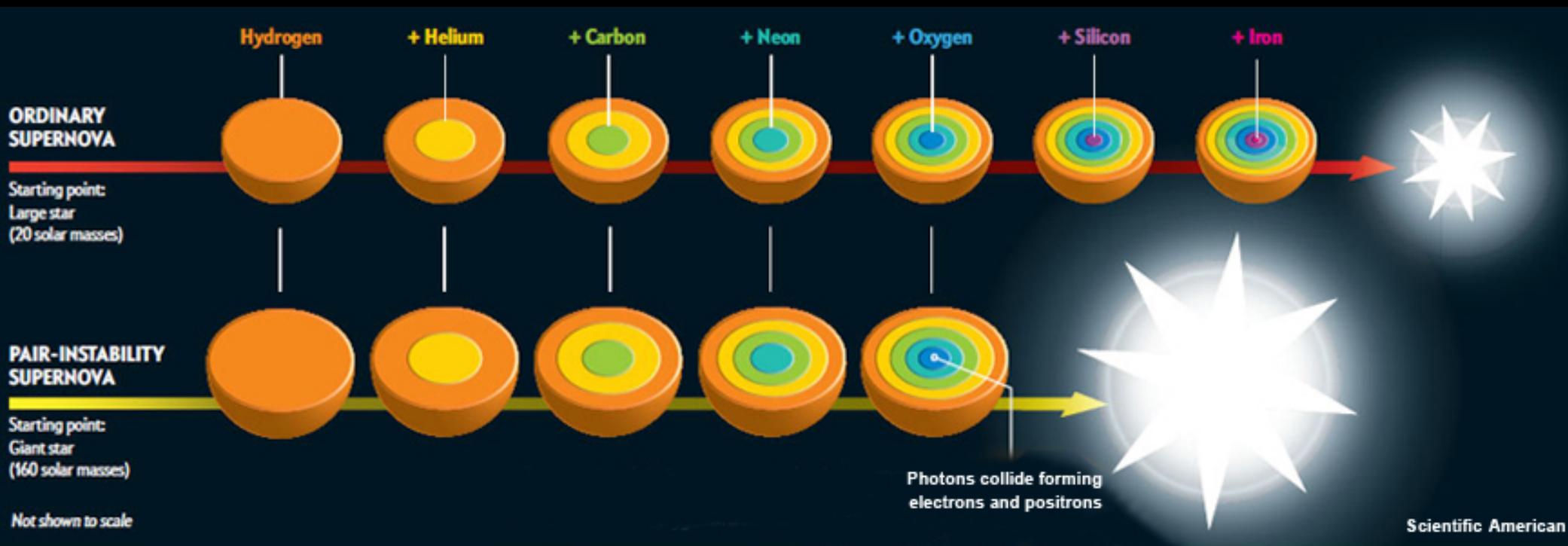


Pair-instability



Pair-instability Supernova

- Proposed in the late 1960s by Barkat (1967), Rakavy (1967) and Fraley (1968).

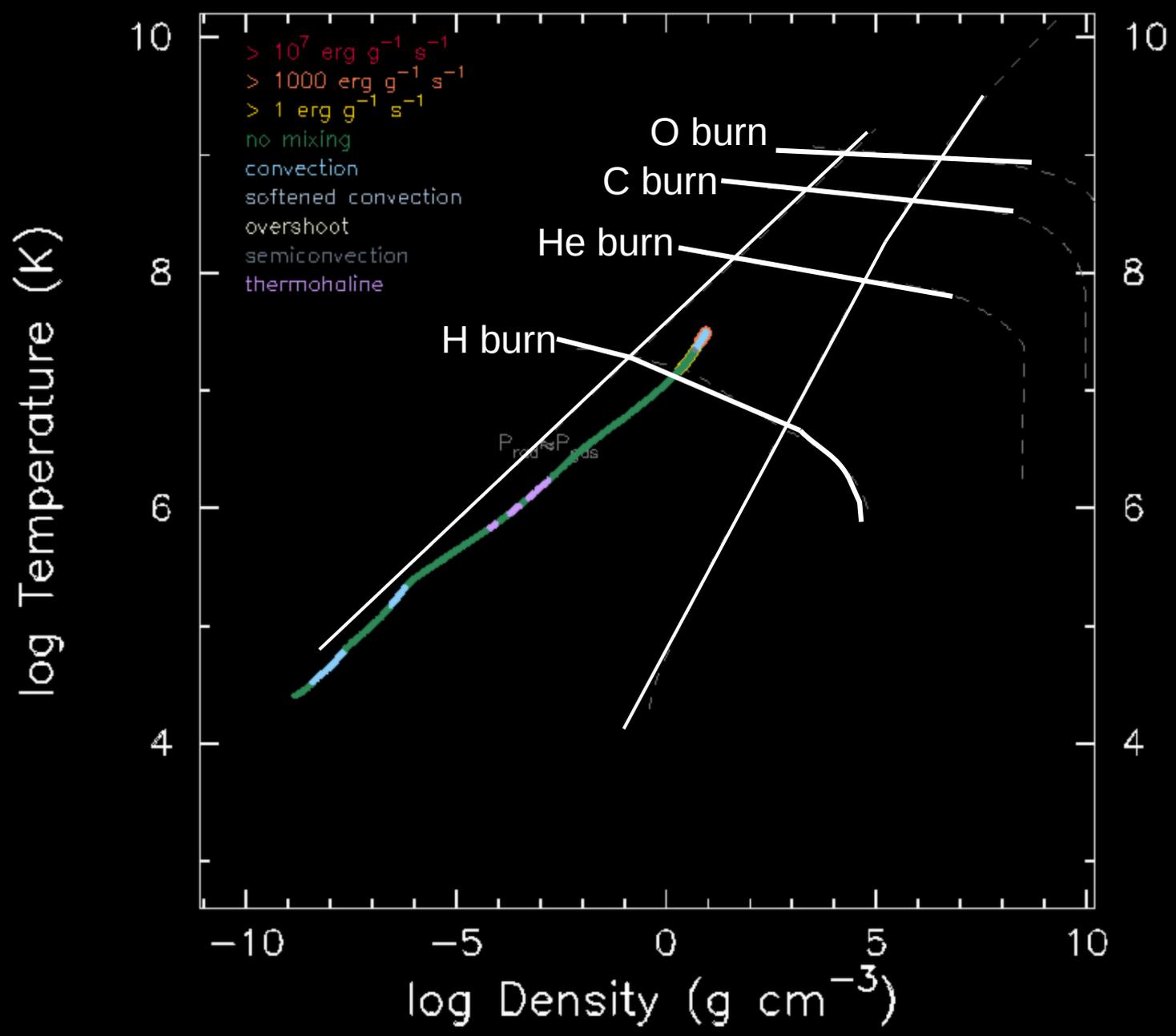


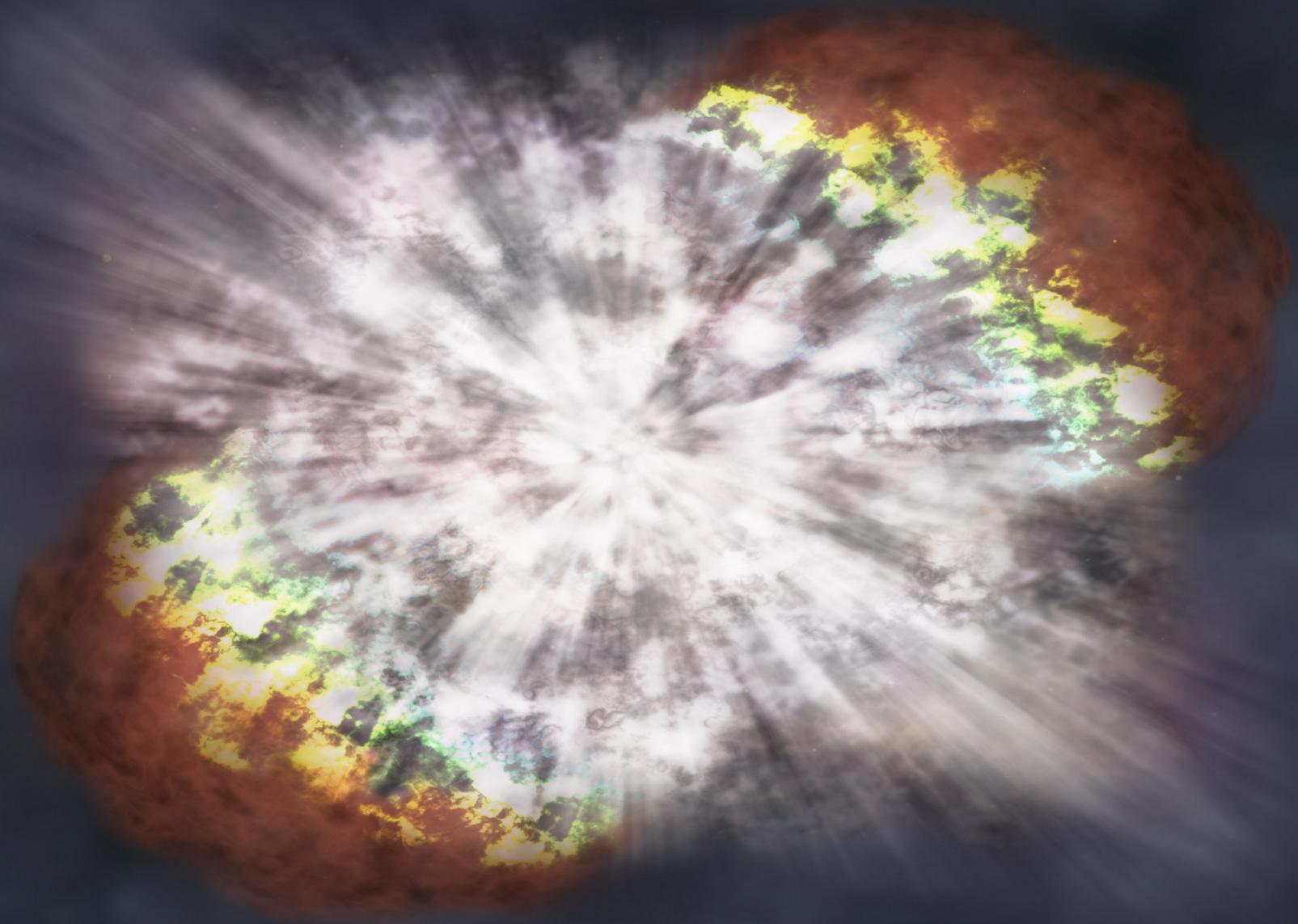
Pair-instability Supernovae leave NO remnant!

age 74.416000 yrs

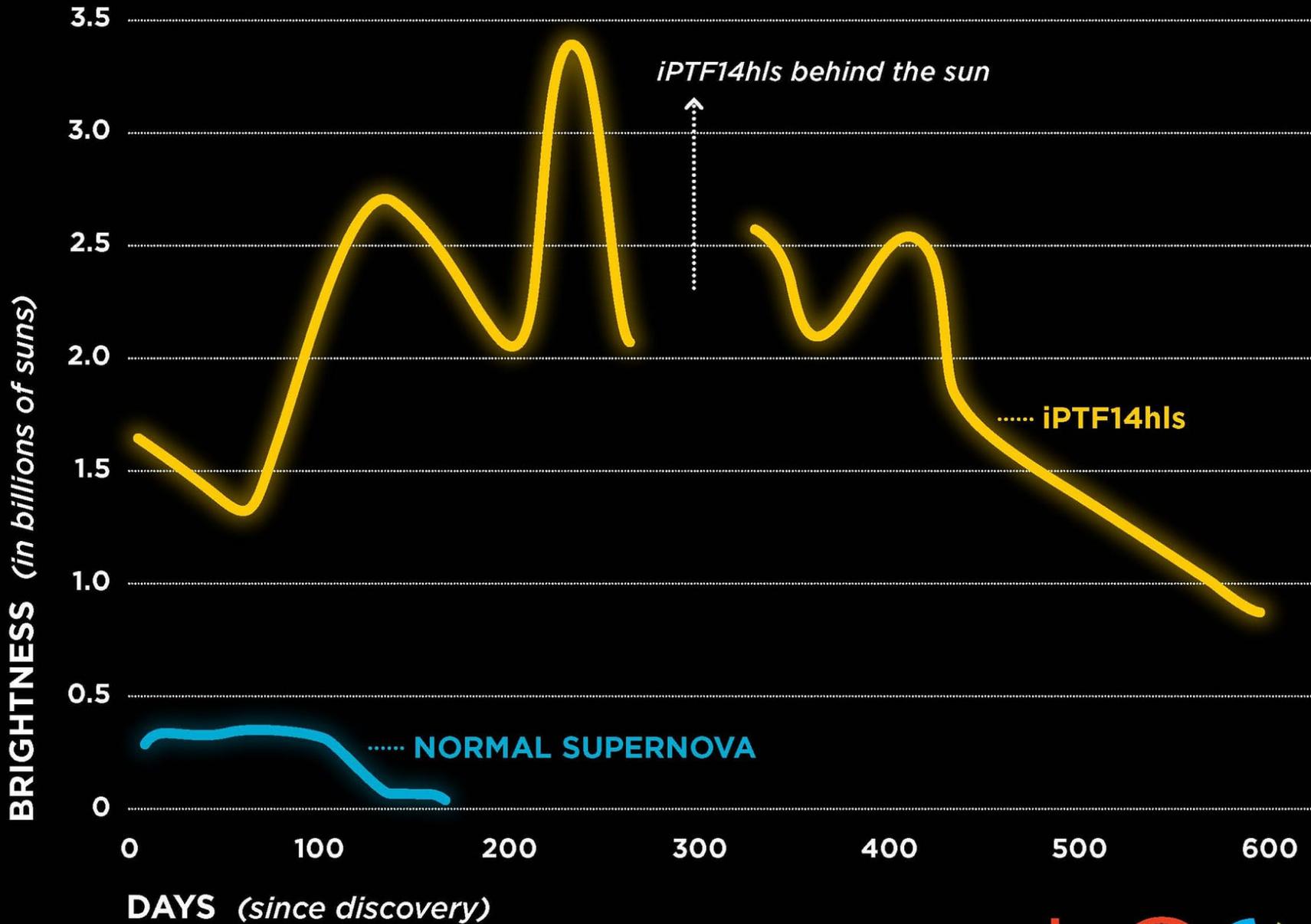
TRho_Profile

model 5





SN 2006gy
NOT a PISN



Conclusions

- What is a star?: “A star is a **luminous sphere** of plasma **held together by its own gravity**.”
- The life of single stars: they burn lighter elements into heavy elements, growing a core, and they expand.
- The death of stars: **WD, NS, BH...**
- Beyond: ...and **PISN(?)**