بسم الله الرحمن الرحيم

AECENAR

Association for Economical and Technological Cooperation in the Euro-Asian and North-African Region

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TYPE-II SUPERNOVA PROGRAM

MARYAM ABDEL-KARIM

طاقة الشمال

North Lebanon Alternative Power

www.nlap-lb.com

PLAN

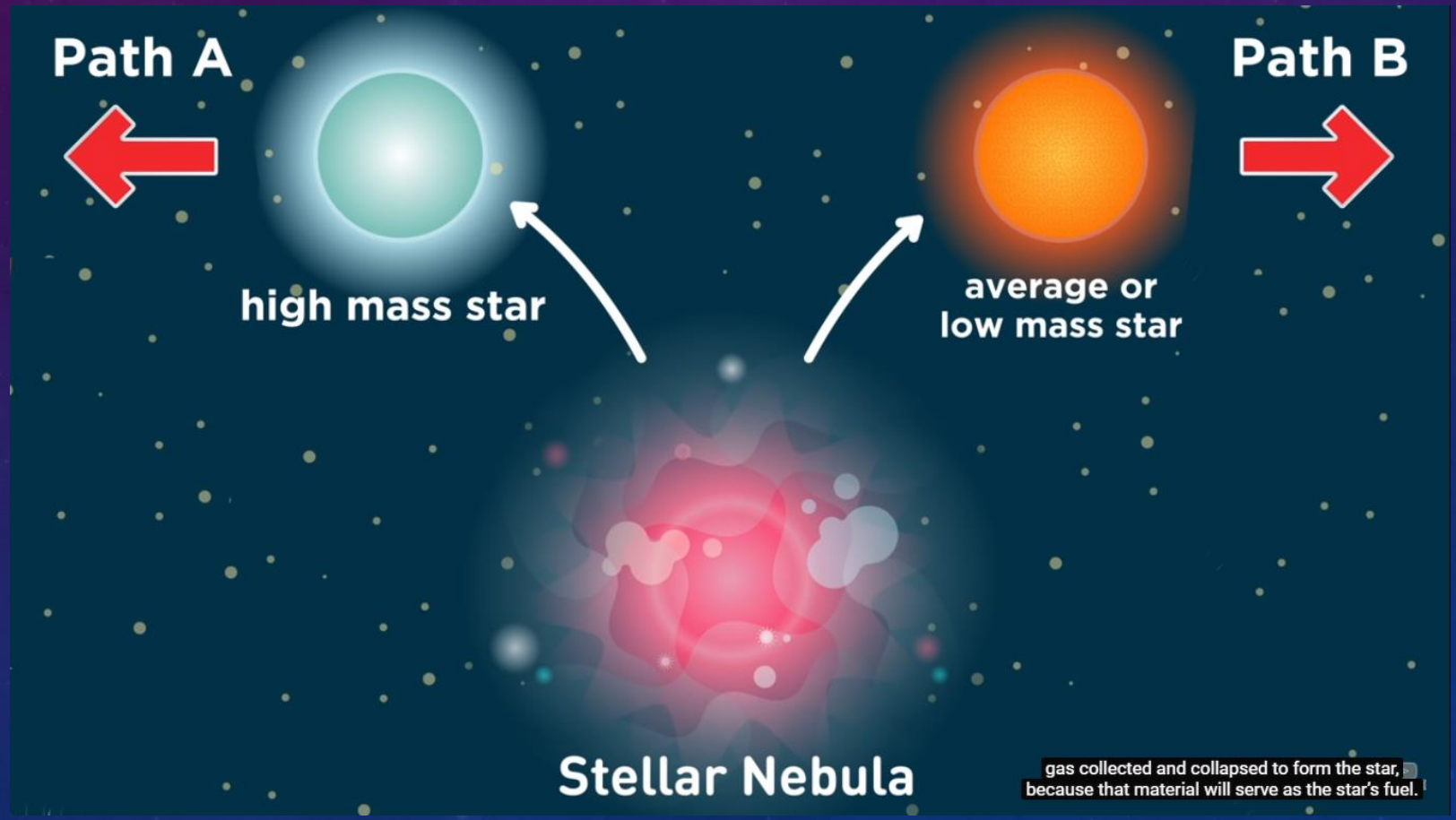
- Principle:
  - Stars types
  - Star Mass
  - Fusion
  - Average or low mass stars
  - Heavy stars
- Type-II Supernova program
  - Assumptions
  - Discretization
  - Stellar composition
  - Applications

STAR TYPES

- Main sequence:
  - Blue stars: big, hot, bright (up to 200 solar masses)
  - Yellow stars: in between (close to 1 solar mass)
  - Red stars: small, cool, dim (down to 0.1 solar masses)
- Red Giant: red and cool (0.3-8 solar masses)
- White dwarf: tiny and hot (0.2- 1.3 solar masses)

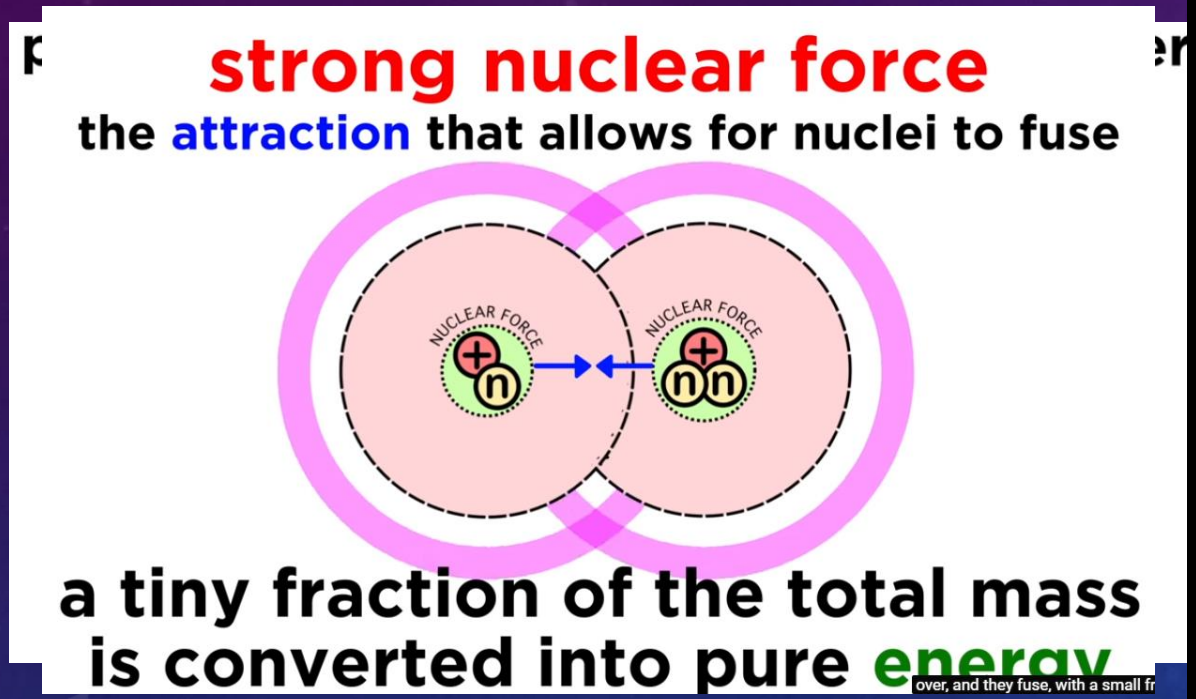
STAR MASS

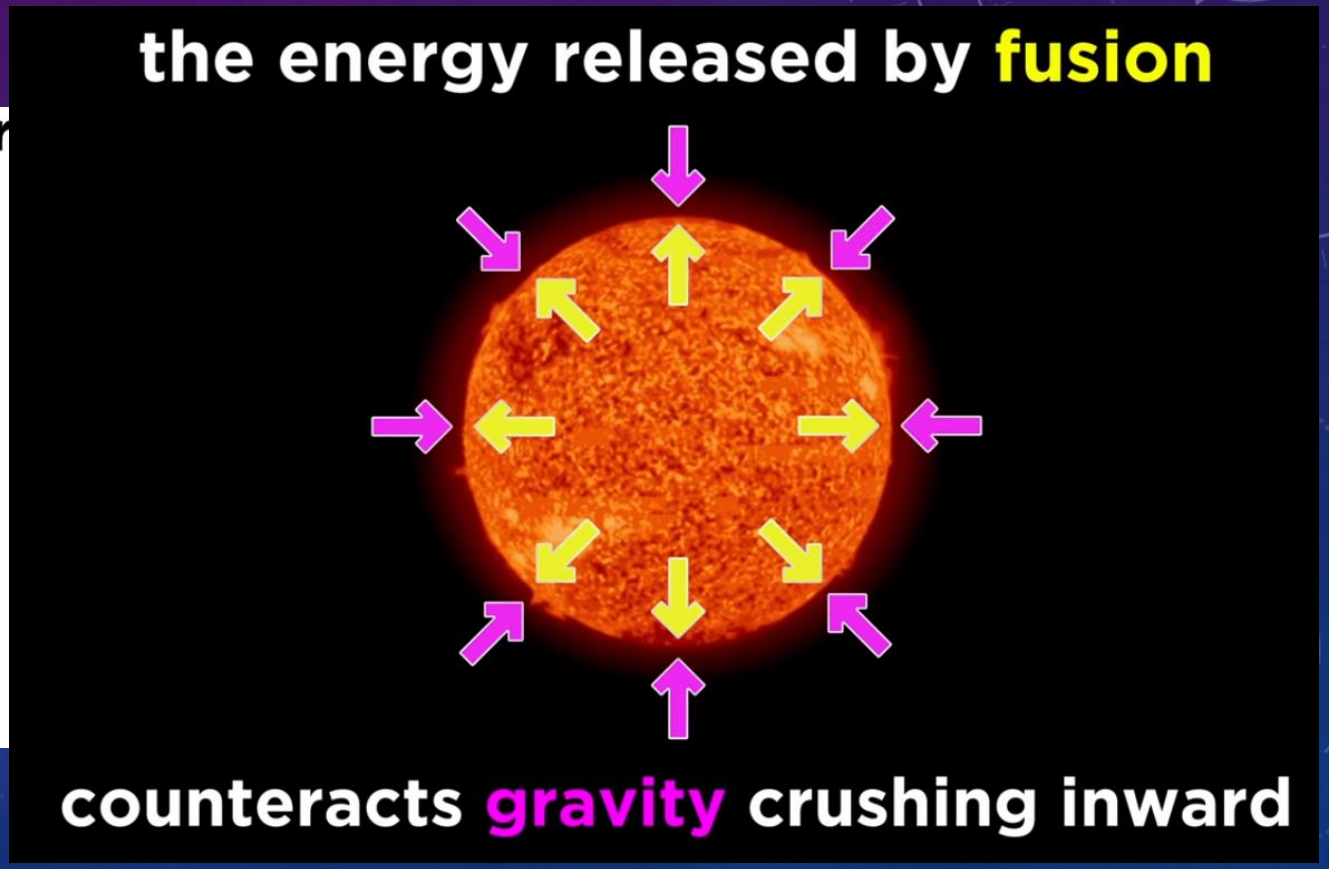
- Star lives for millions or billions of years.
- The path that will be followed by a particular star depend mainly on its mass, or how much gas collected and collapsed to form the star because that material will serve as the star's fuel



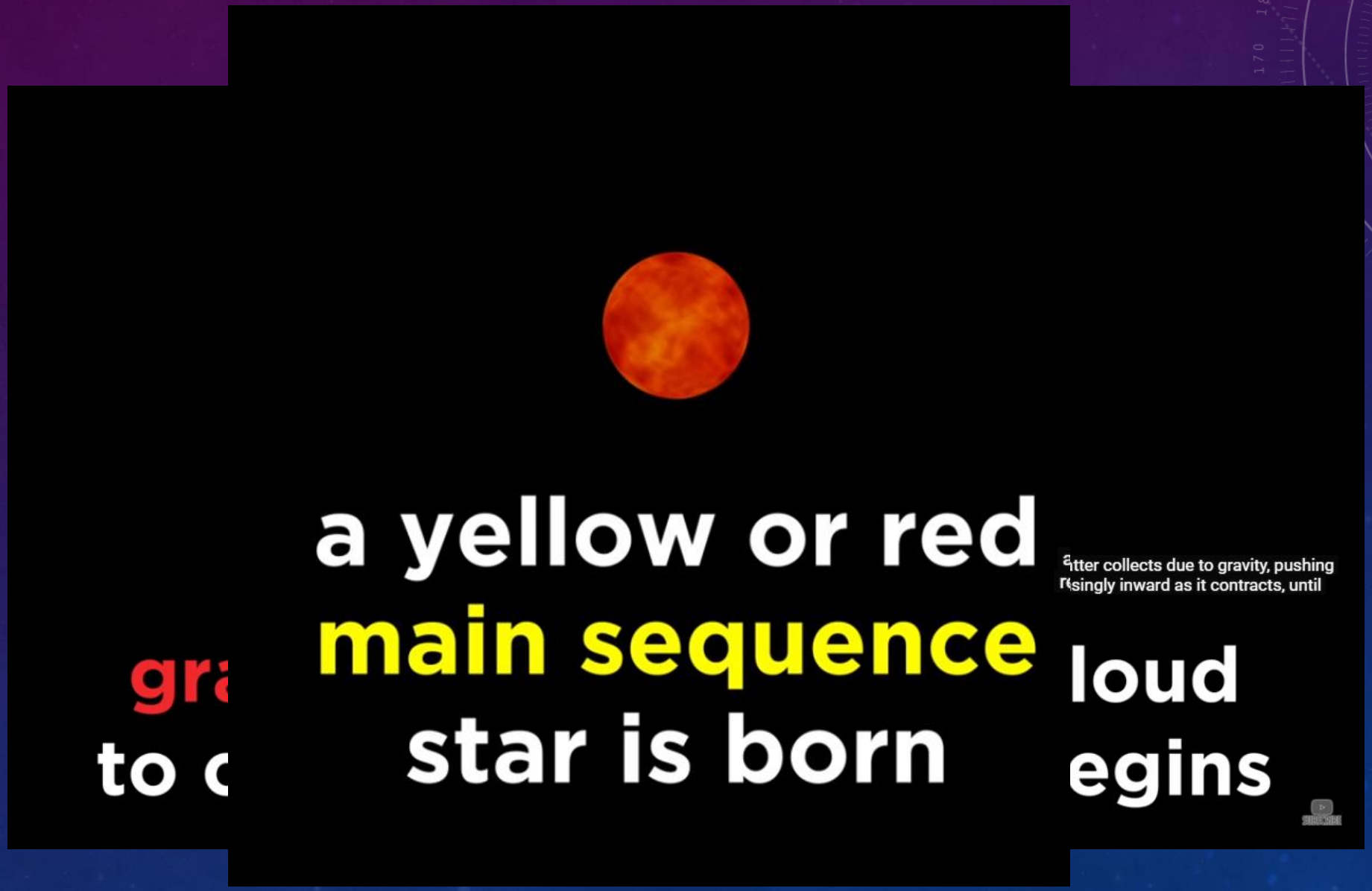
FUSION

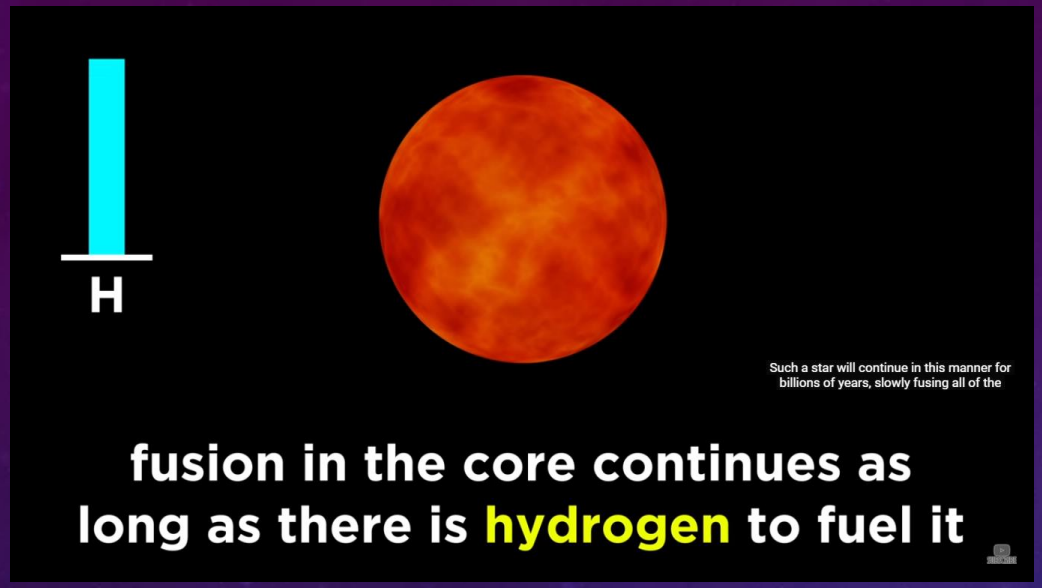
- Electromagnetic force

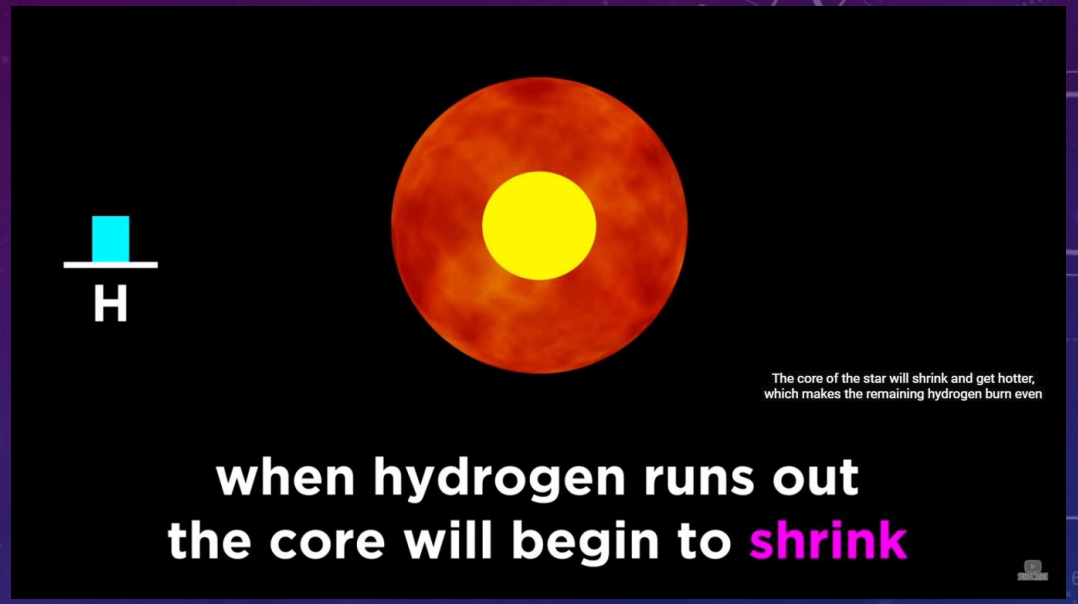




AVERAGE OR LOW MASS STARS




H
Such a star will continue in this manner for billions of years, slowly fusing all of the
fusion in the core continues as long as there is hydrogen to fuel it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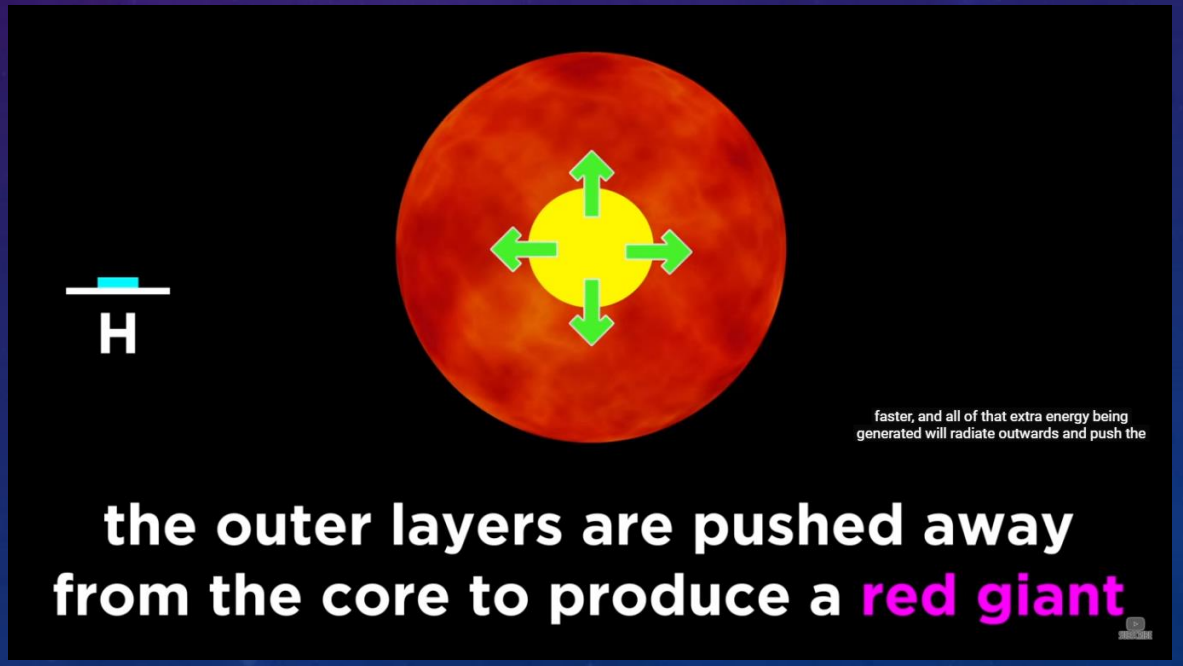
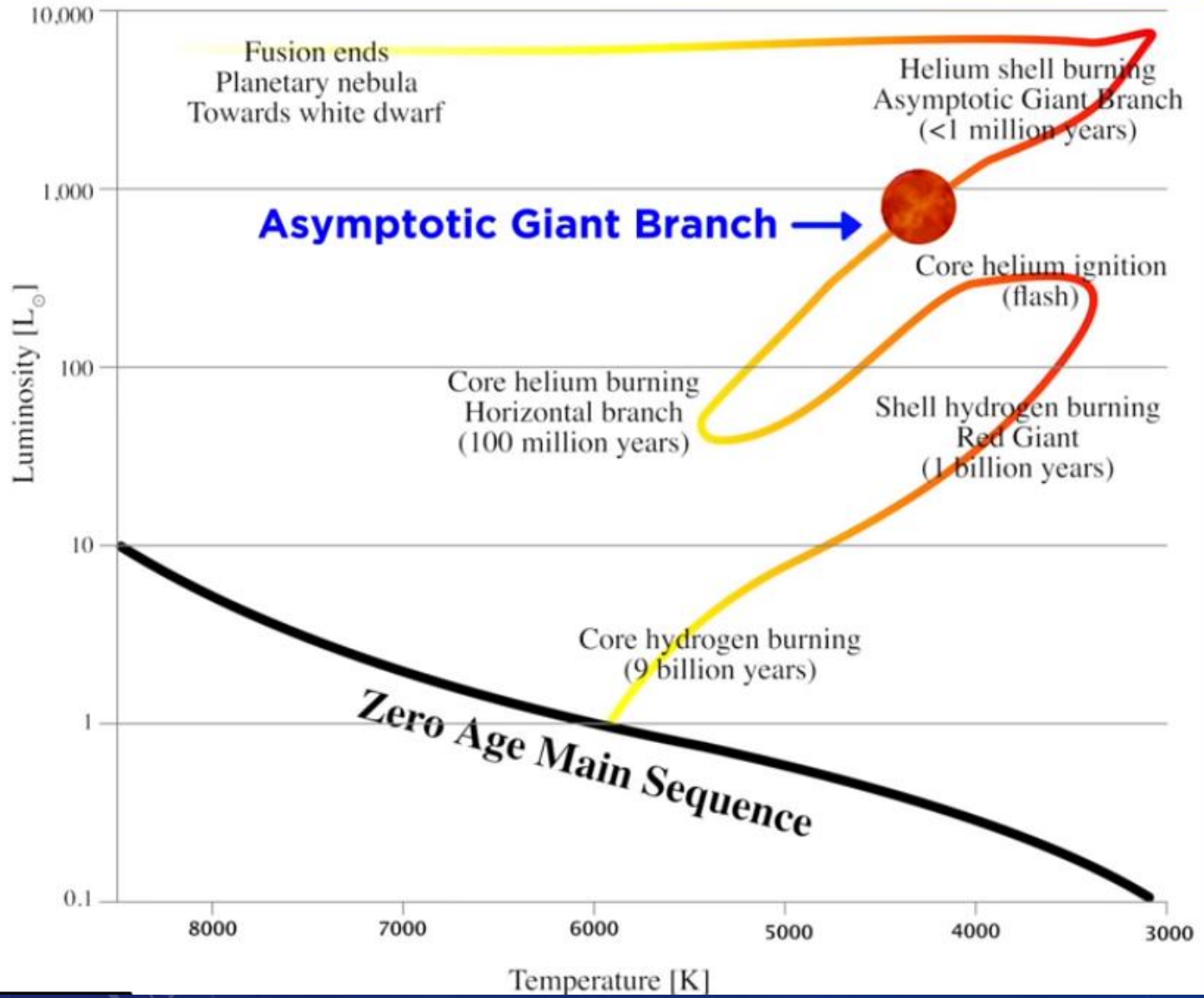
The core of the star will shrink and get hotter, which makes the remaining hydrogen burn even
when hydrogen runs out the core will begin to shrink

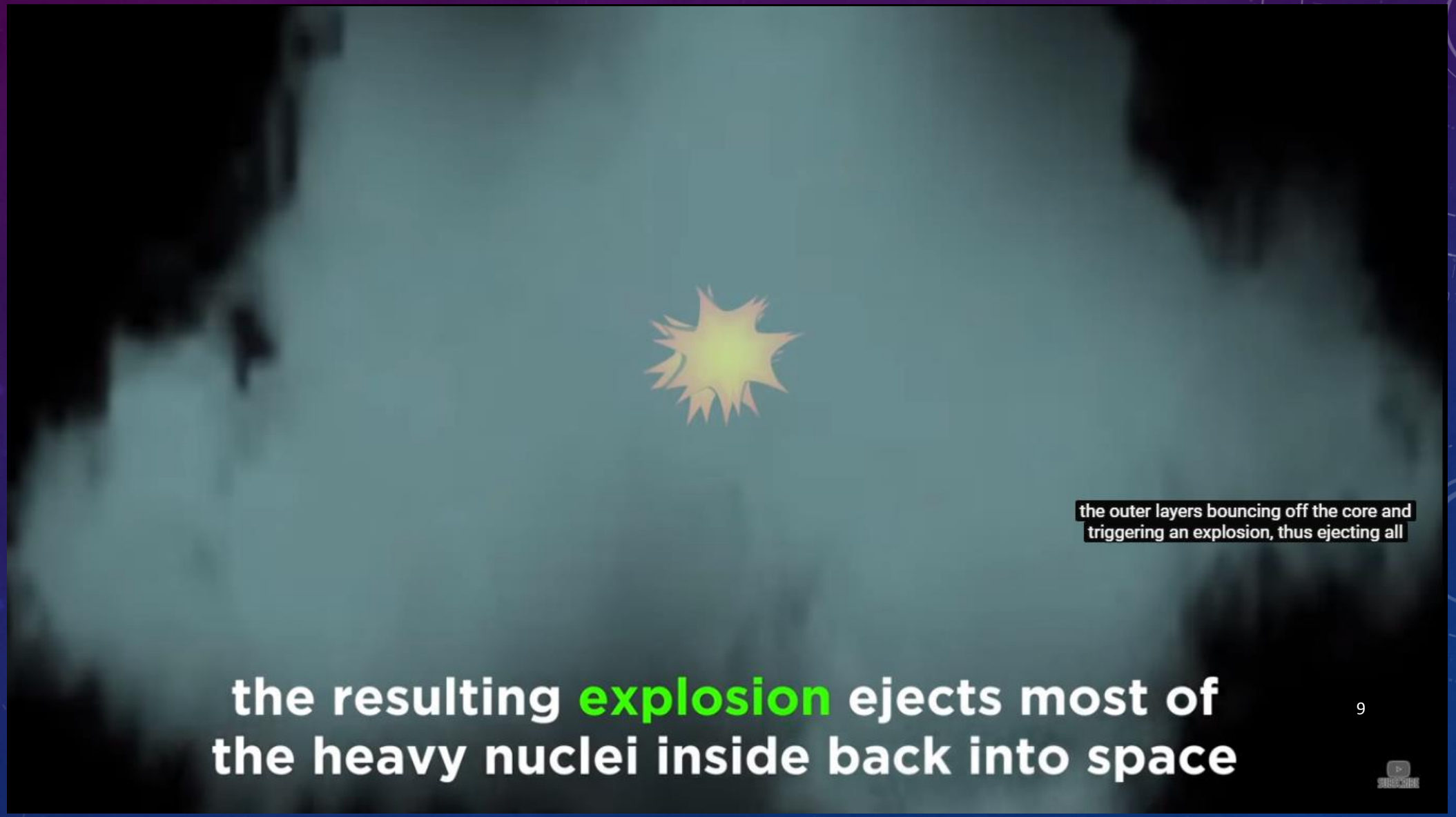

H
faster, and all of that extra energy being generated will radiate outwards and push the
the outer layers are pushed away from the core to produce a red giant



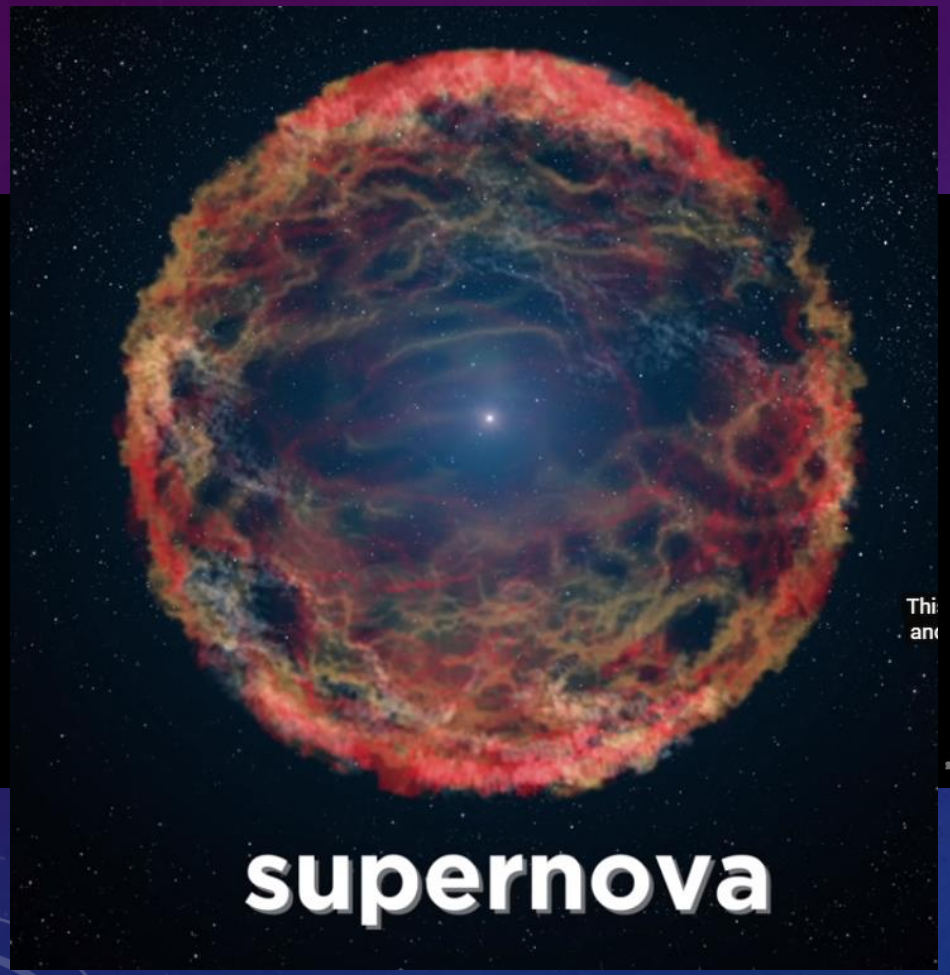
earth-sized core

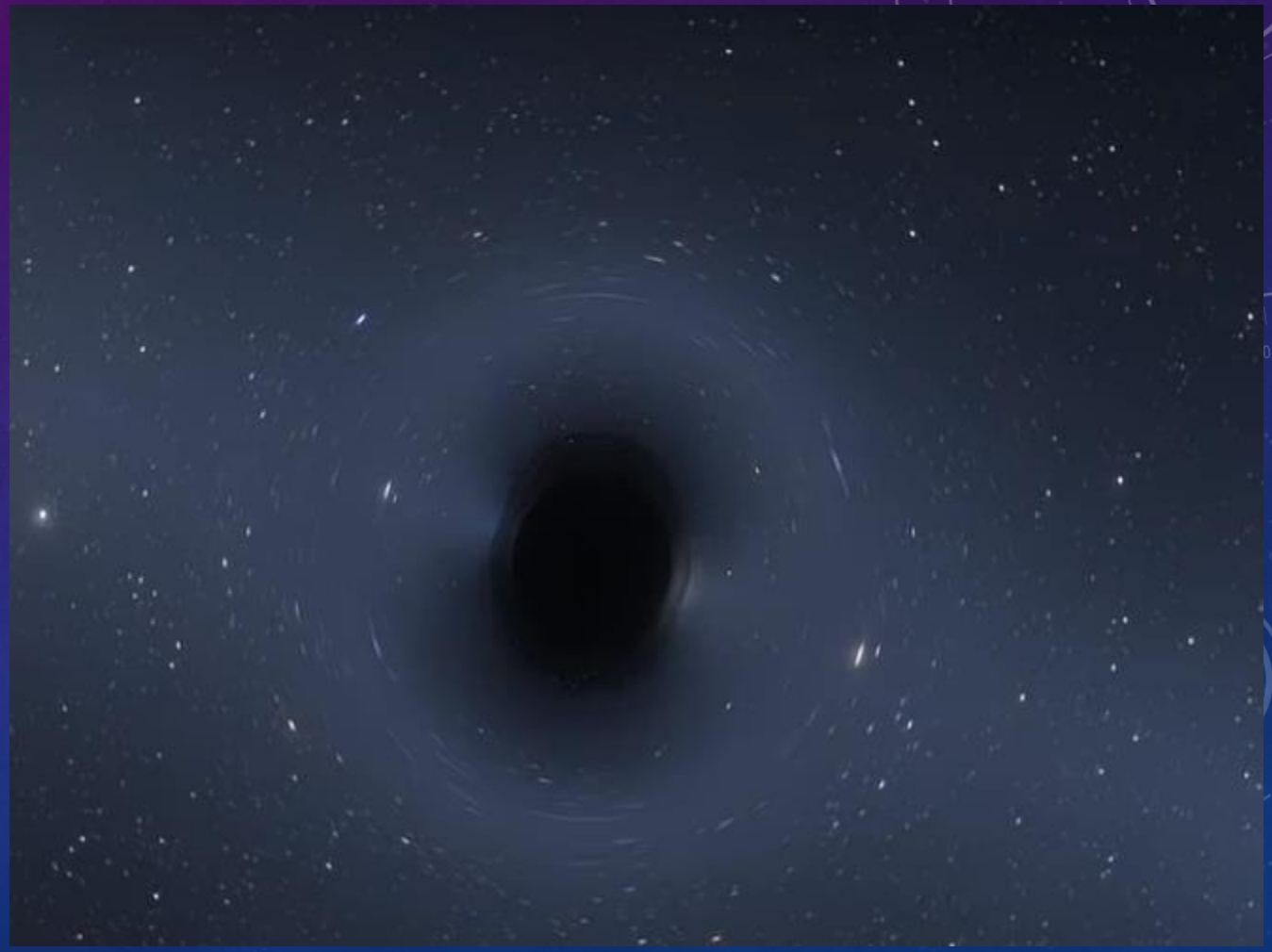
not enough gravity to overcome
electron degeneracy pressure

HIGH MASS STARS



CHANDRASEKHAR LIMIT



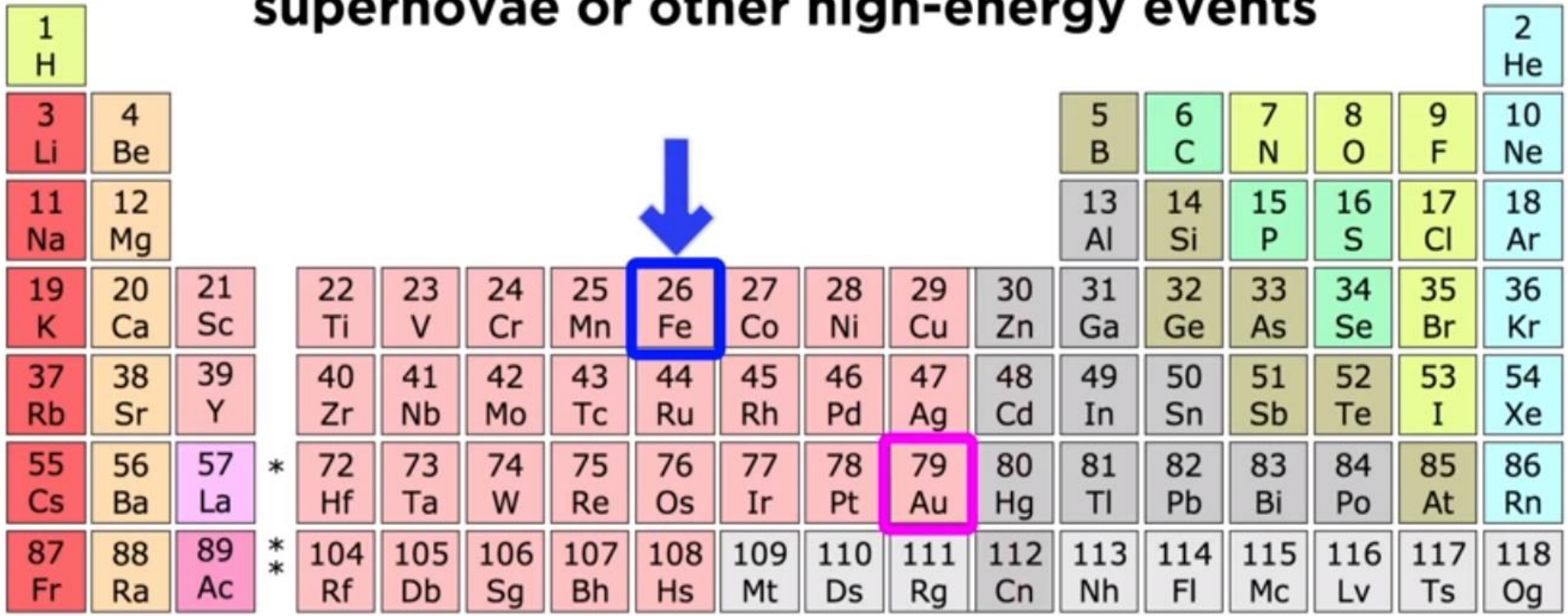


elements with an atomic number greater than 26 are fused only during:

supernova

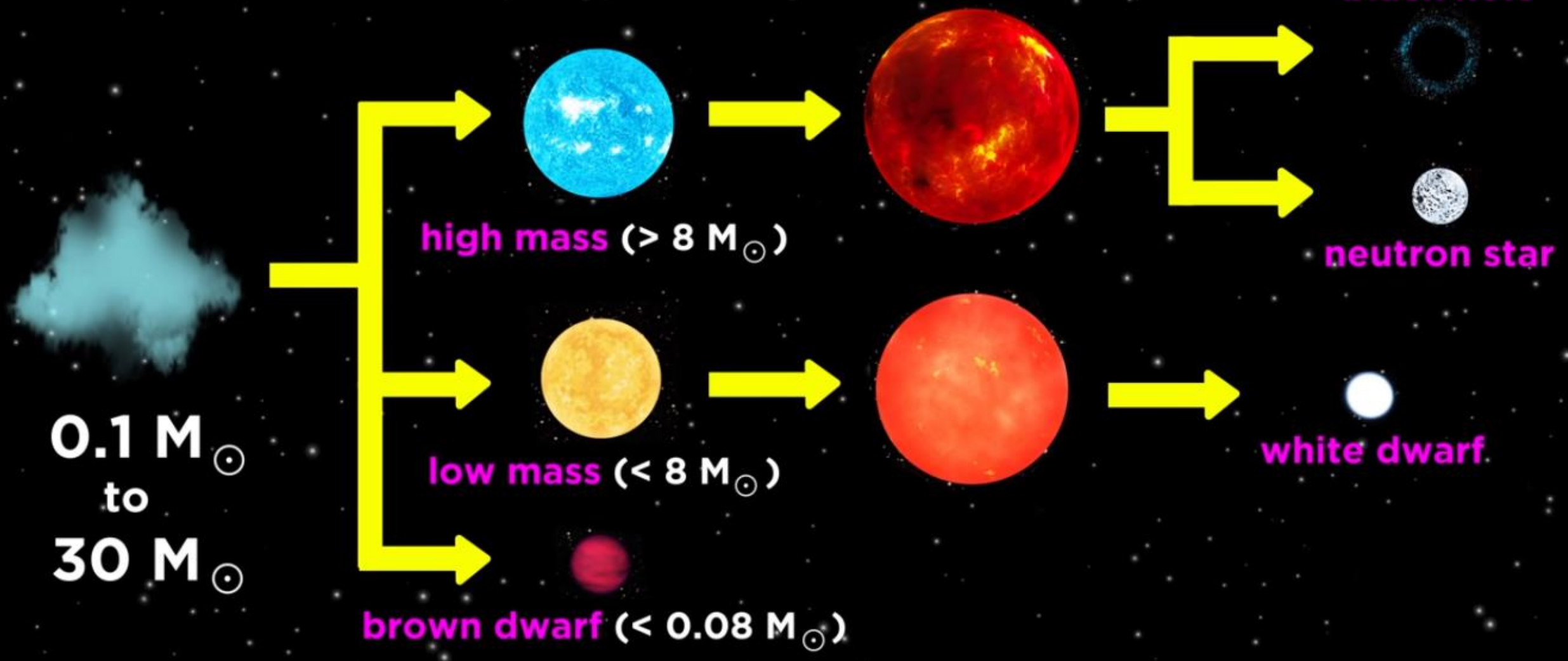
(or the s-process within AGB stars)

elements heavier than iron are made only in supernovae or other high-energy events



Then finally, when the star can no longer perform sufficient nuclear fusion so as to

Stellar Life Cycle



3 fuel runs out and the star will collapse

TYPE-II SUPERNOVA PROGRAM

- Basics Assumptions:
  - Spherical symmetry (The star's properties are assumed to have no angular dependence)
  - Gas composition (it is assumed that the star consists of a mixture of photon gas and ideal classical gas)
  - Homogeneous distributions (the same value for the density, pressure, and temperature hold at each radial position inside a certain shell. In the model, these quantities are evaluated in the middle of shells)

NUMERICAL MODEL

- In this model, the star is divided into a number of spherical shells.
- These shells contain stellar material with a certain density, temperature, pressure and internal energy.
- The matter within a shell is regarded as being isolated from the matter within other shells.The shell may change in volume but the same mass remains inside of it.
- The dynamics of the star can be simulated by studying the movement of these spherical shells. By looking at the way in which the radial position of each shell changes due to gravity and pressure, gives an understanding of the dynamics of the star as a whole.

$$P = \frac{a}{3}T^4 + \frac{\rho k_B T}{\mu},$$

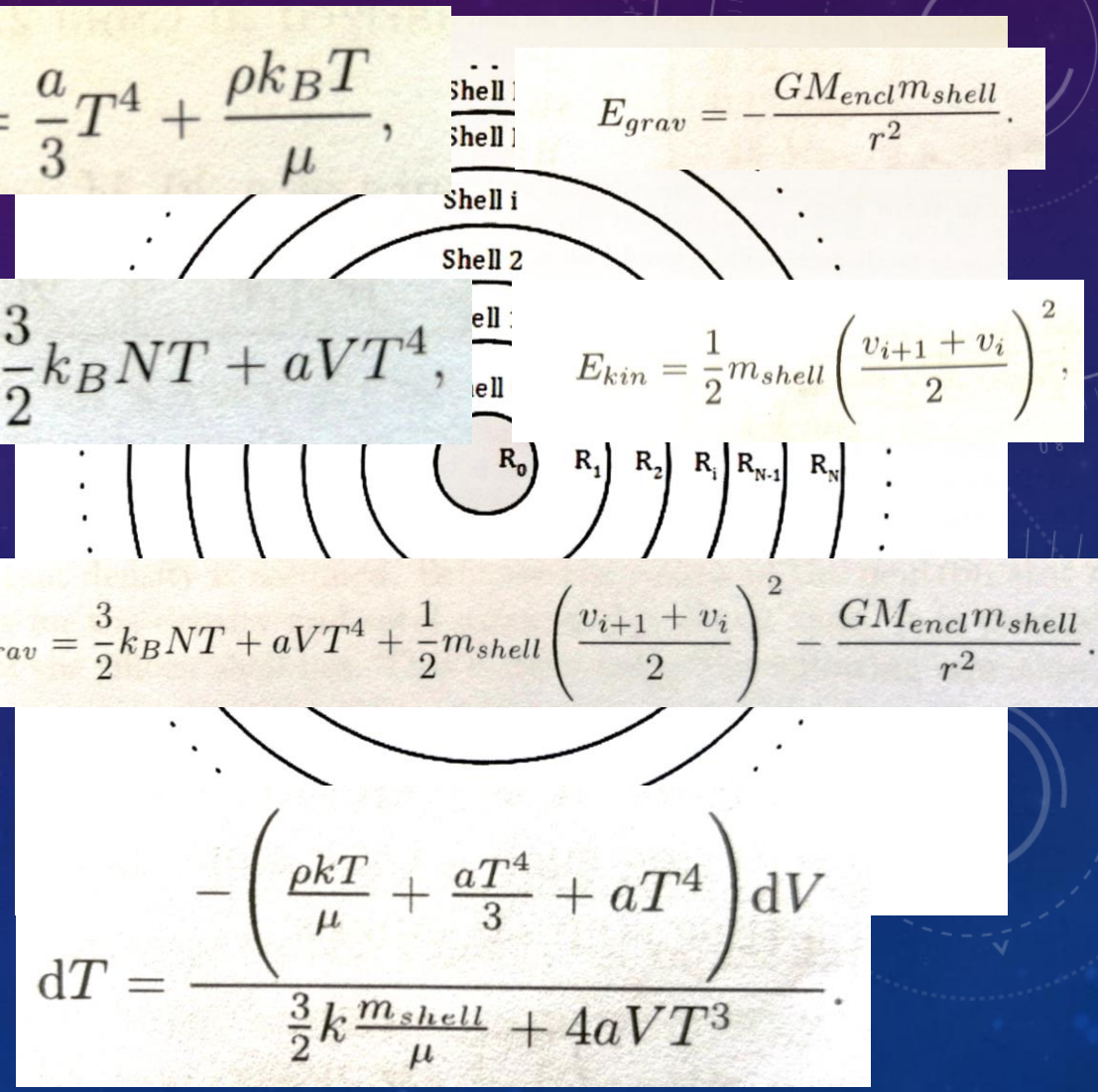
$$E_{grav} = -\frac{GM_{encl}m_{shell}}{r^2}.$$

$$U = \frac{3}{2}k_B NT + aVT^4,$$

$$E_{kin} = \frac{1}{2}m_{shell}\left(\frac{v_{i+1}+v_i}{2}\right)^2,$$

$$U + E_{kin} + E_{grav} = \frac{3}{2}k_B NT + aVT^4 + \frac{1}{2}m_{shell}\left(\frac{v_{i+1}+v_i}{2}\right)^2 - \frac{GM_{encl}m_{shell}}{r^2}.$$

$$\mathrm{d}T = \frac{-\left(\frac{\rho kT}{\mu} + \frac{aT^4}{3} + aT^4\right)\mathrm{d}V}{\frac{3}{2}k\frac{m_{shell}}{\mu} + 4aVT^3}.$$

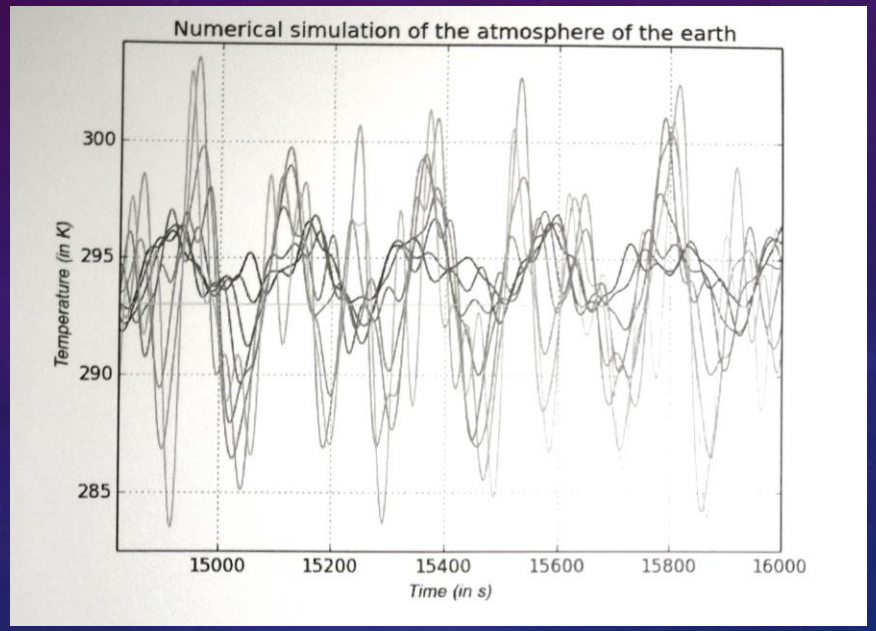


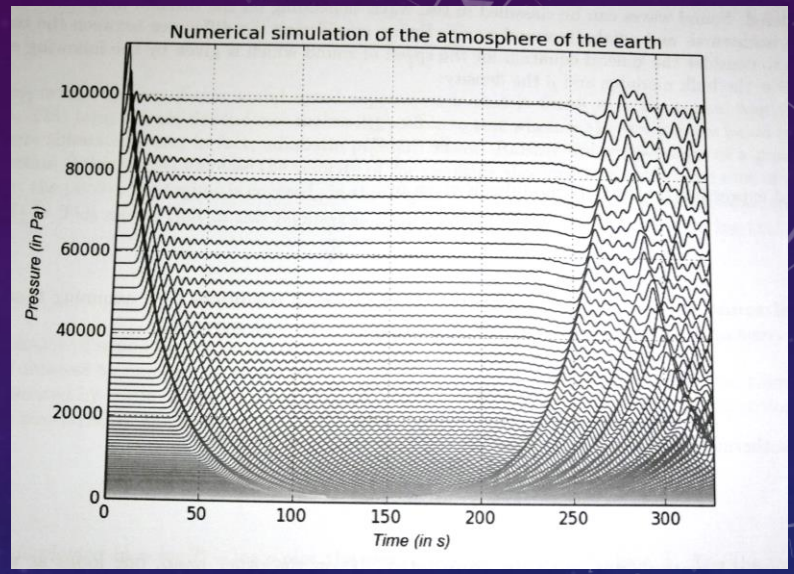
STELLAR COMPOSITION

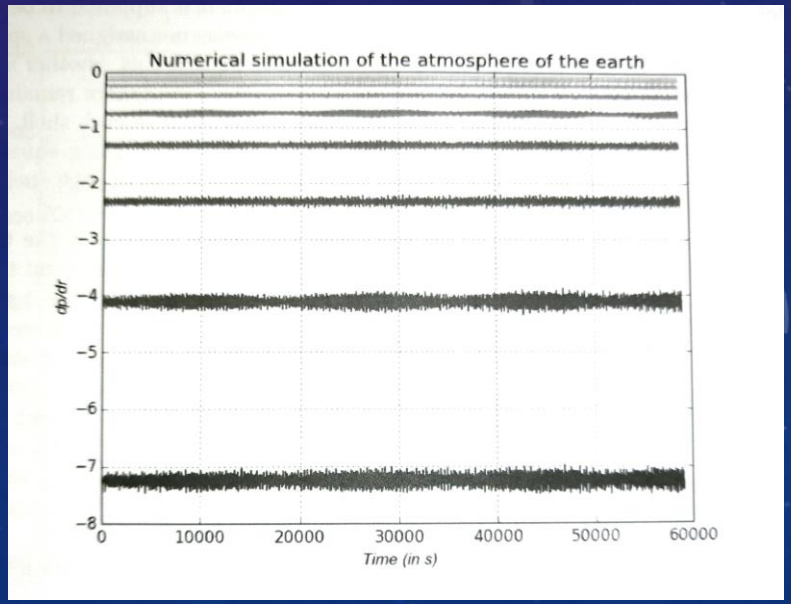
- Two different aspect of stellar composition are considered :
  - A neutron star core
  - Red giant star
- Neutron star core model: The star contains only the element hydrogen, and a neutron star at its core
- Red giant star model: The stellar material is assumed to consist of approximately 90% hydrogen and a stellar core of iron, the stellar atmosphere is divided into layers of different elements.

APPLICATIONS

- The type-II supernova program couldn’t simulate the typical supernova explosion due to instability of the code, but various successful tests were performed on a more simple, earth-like atmosphere, it can be concluded that the supernova model work correctly.







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