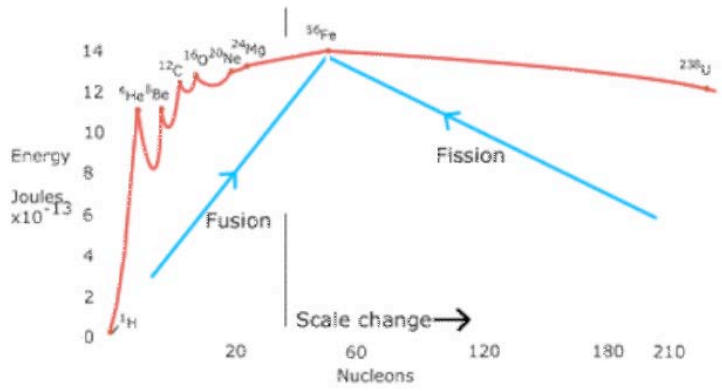
Binding Energy Diagram

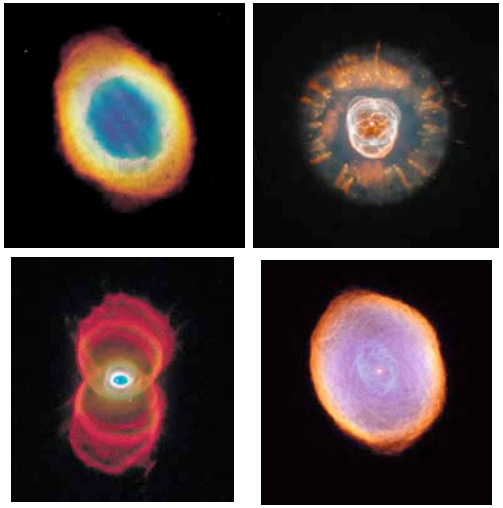


- Fusion generates energy until it reaches the "iron peak".
- Fission generates energy by destroying nuclei heavier than iron.

Burn heavier nuclei

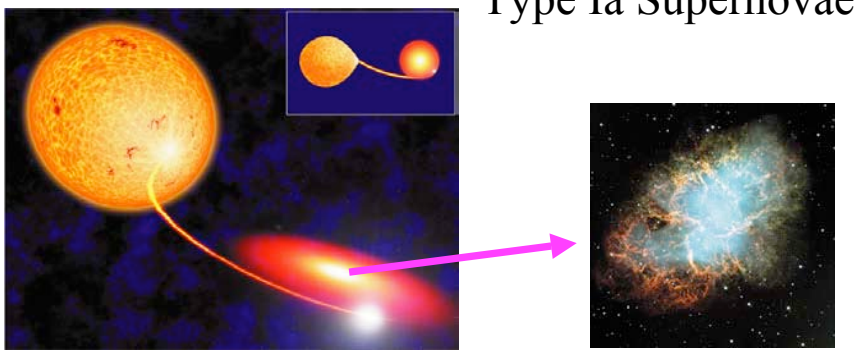
- When protons (or hydrogen nuclei) are exhausted, stars begin to contract.
  - Inert helium core
  - Hydrogen-burning shell
- When temperature in the core increases to ~100 million degrees K, helium begins to burn, generating nuclear energy again. The surface of the star expands.
  - $^4He + ^4He + ^4He + ^4He \rightarrow ^{12}C$ + (binding energy)
  - Inert carbon core
  - Helium-burning shell
  - Hydrogen-burning shell
- When helium nuclei are exhausted, the star wants to burn carbon, but a low-mass star can't burn it…
  - $^{12}C + ^4He \rightarrow ^{16}O$ + (binding energy); this reaction requires ~600 million K! So, a low-mass star becomes a carbon star.

White Dwarfs and Planetary Nebulae



- Expanding gas gets **ionized** by radiation from the central core
- The core
  - White dwarf
  - Supported by "*degeneracy pressure*"
- The expanding gas
  - Planetary nebula

Type Ia Supernovae



- If the W.D. has a companion star, mass from the companion accretes on the W.D., increasing mass.
- At some point ($M>1.4M_{solar}$), carbon begins to burn!
  - The "carbon bomb" disrupts the W.D. completely
  - This type of supernova is called the "Type Ia", and plays a very important role in cosmology