Implications for Stars

Concept 1 - H.S.E.

- Pressure required for support
- KH Timescale to Radiate Binding Energy
- Radiation pressure and instability $\Rightarrow$ Mupper

Concept 2 - Heat Transport

- Specific Heat and mean free path $(e^{-\frac{\mu}{c}})\,\text{cm}^2\,\text{s}^{-1}$
- opacity
- optical depth unity; scale-height $\Rightarrow$ atmospheric $T_{eff}$

Concept 3 - Energy Generation by Thermonuclear Fusion

- Rate of energy generation
- Slope of main sequence
- Minimum burning mass
- Stellar lifetimes
- Evolution up the Giant Branch; Horizontal Branch
- When/where convection occurs
- Basic Abundance Patterns

Concept 4 - Non-classical physics

- Tunneling
- Degeneracy Pressure $\Rightarrow$ minimum stellar mass; RGB
- Chandrasekhar mass; supernovae
- neutron stars

- Saha Equation $\Rightarrow$ Abundances of species in chemical equilibrium
- Nuclear Rx rates $\propto \frac{1}{\tau}$
- Disintegration of nuclei in core collapse
- Ionization of Atmospheres $\Rightarrow$ Observed spectra
- Cepheid variables (H)
Nuclear Fusion

nuclear structure – size; n/p ratio; binding energy
getting under the Coulomb barrier \( E_c = (n \times 2 + 2) \frac{2m_e e^2}{r} \)
Reaction Rates \( \langle u \rangle \); \( E_0^3 = \frac{E_0}{\hbar \tau} (\hbar T)^2 \); T dependence
when cno and pp cycle are important; main sequence
He burning – when important; evolution in HR diagram
Advanced burning – element synthesis; photo-dissociation

HR Diagram
-
Minimum H burning mass
-
Maximum mass of stable star
-
Slope of Main sequence
-
Where convection occurs
-
MS lifetimes
-
White Dwarf Cooling Line
-
Location/Cause of Red Giant Branch; HB
-
Ionization State of Stellar Atmospheres; Spectral Type
-
Life cycle of 1M\(_\odot\), 5M\(_\odot\), 20M\(_\odot\) star
-
Why \( M \sim L^3 \)

Quantum Mechanics

degeneracy – when \( M \) important \( n \); when relativistic
\( \hbar \), de Broglie \( \lambda \)
pressure from a degenerate gas – NR vs. UR; Mehydro
core collapse; \( M_{\text{min}} \)
ionization balance; disintegration of nuclei; saha eqn