

Main Sequence Evolution

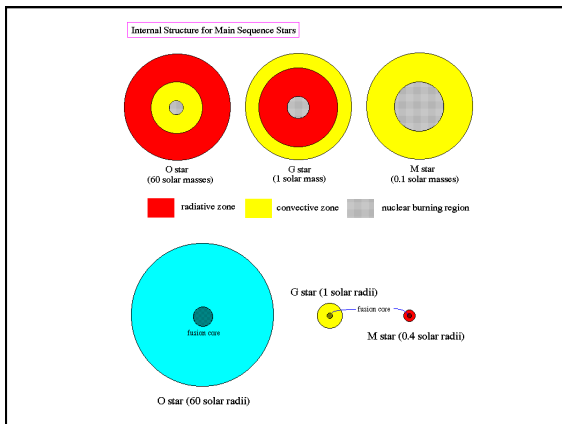
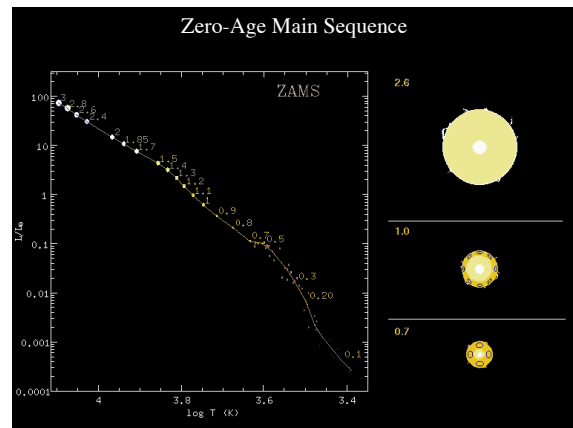
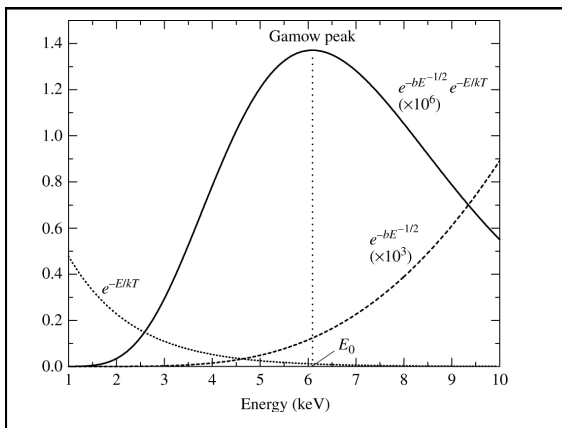
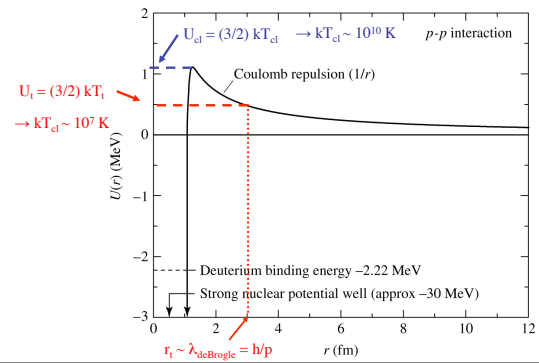
- core hydrogen burning phase

Post Main Sequence Evolution

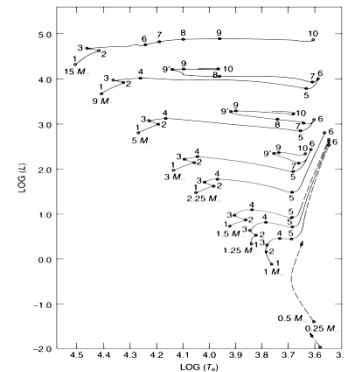
- hydrogen shell burning
- helium burning
- red giant phases
- pulsation and mass loss

THEN: Endpoints of Stellar Evolution

Overcoming the Coulomb Barrier



Evolution During and After the Main Sequence



Evolution of Very Low-Mass Stars

- Brown Dwarfs ($10 M_J < M_{BD} < 0.08 M_\odot$)
 - fusion never ignites
 - Kelvin-Helmholz contraction/cooling
 - fully convective
 - molecular opacities (even deep in atmosphere)
 - end life as “black dwarf”?
- M Dwarfs ($M > 0.08 M_\odot$)
 - PP chain
 - fully convective
 - gradually He enriched; never hot enough to ignite
 - contracts to He-rich white dwarf

Evolution of $1 M_\odot$ Stars

- Radiative core; little or no mixing
- H \rightarrow He; molecular weight goes up (Y increases)
- Sun now ~40:60 H:He in the core
- He ash gravitationally settles in core; not yet hot enough to “ignite”
- core contracts, heats up, increases PP and CNO
- luminosity, temp, radius gradually increases
- once $X < 1$ or 2% (~90% of total lifetime), PP and CNO cannot continue
- core goes out of HSE and TE and contracts
- not hot enough for He fusion; H burns in “shell”

