

Nuclear Physics I: Nuclear Astrophysics

PHYS 8801

Alexander Heger¹

¹Minnesota Institute for Astrophysics
School of Physics and Astronomy
University of Minnesota

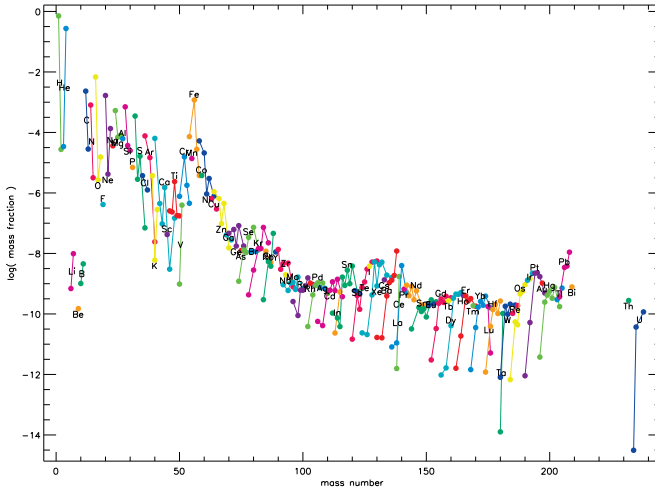
Nuclear Physics I: Nuclear Astrophysics, Spring 2012

Agenda

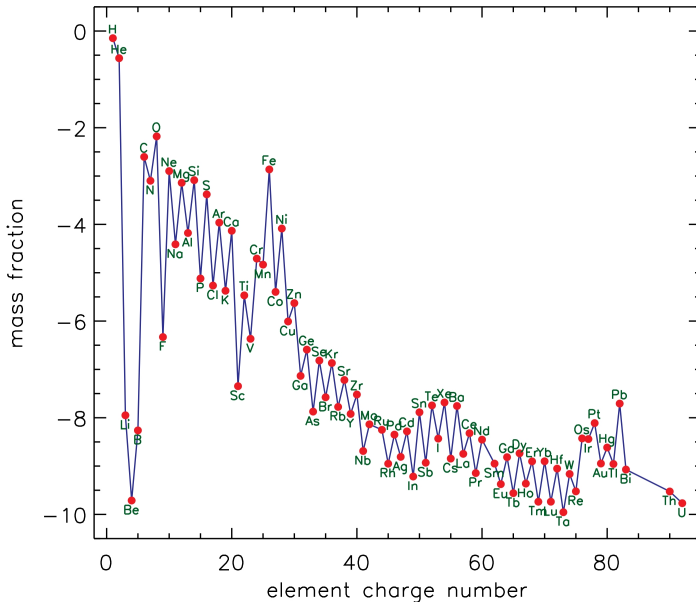
1 Introduction

- Origin of the Elements
- Composition of Earth
- Evolution of a Star
- Stellar Populations

Isotopic Composition of the Sun



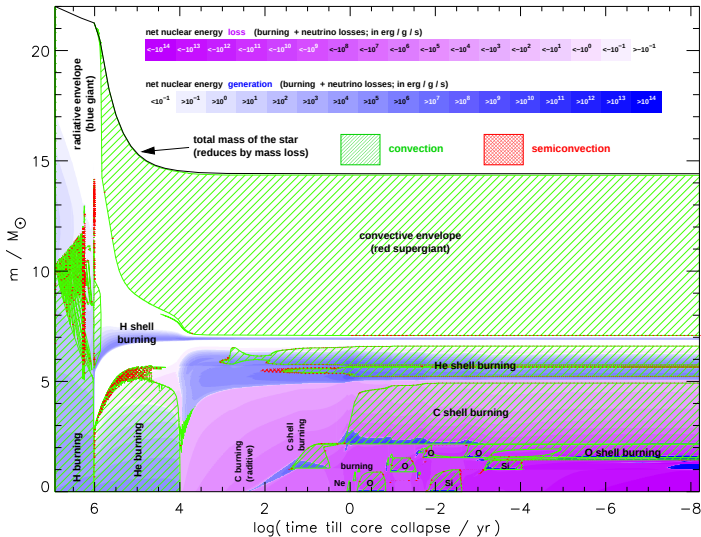
Elemental Composition of the Sun



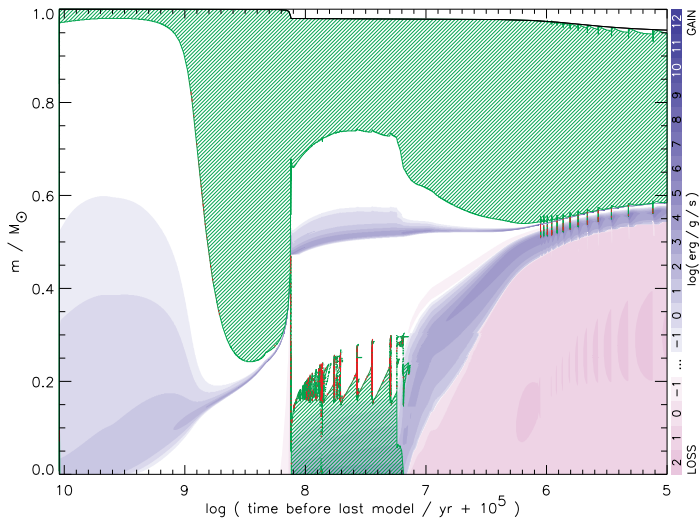
Composition of Earth



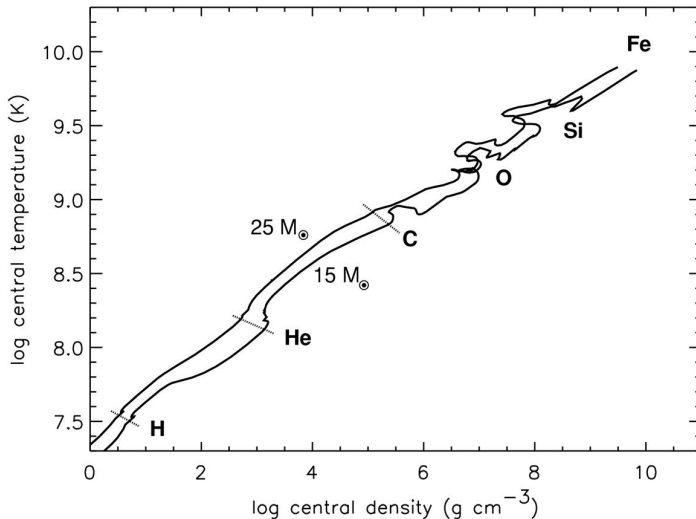
Evolution of a 22 $M_{\odot}$ Star



Evolution of a $1 M_{\odot}$ Star



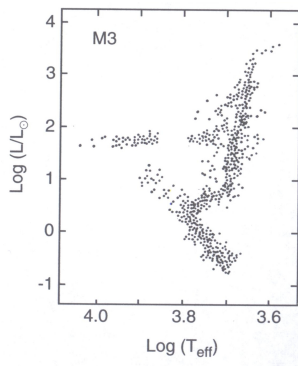
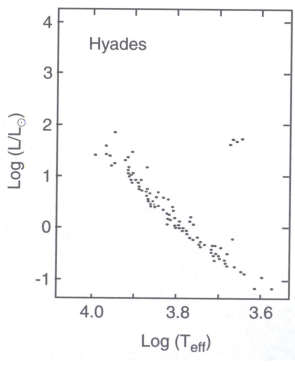
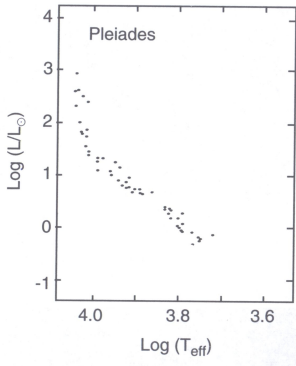
Evolution of central Temperature



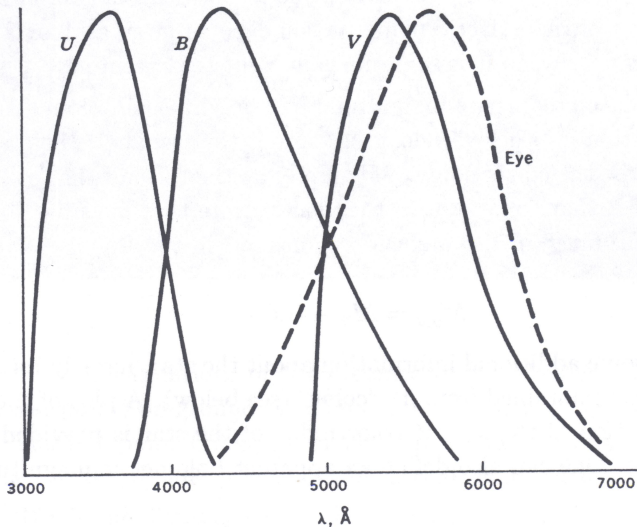
Burning stages in a $20 M_{\odot}$ Star

Fuel	Main Product	Secondary Product	T (10^9 K)	Time (yr)	Main Reaction
H	He	^{14}N	0.02	10^7	$4 \text{H} \xrightarrow{\text{CNO}} {}^4\text{He}$
He	O, C	^{18}O , ^{22}Ne s-process	0.2	10^6	$3 \text{He}^4 \rightarrow {}^{12}\text{C}$ ${}^{12}\text{C}(\alpha, \gamma) {}^{16}\text{O}$
C	Ne, Mg	Na	0.8	10^3	${}^{12}\text{C} + {}^{12}\text{C}$
Ne	O, Mg	Al, P	1.5	3	${}^{20}\text{Ne}(\gamma, \alpha) {}^{16}\text{O}$ ${}^{20}\text{Ne}(\alpha, \gamma) {}^{24}\text{Mg}$
O	Si, S	Cl, Ar, K, Ca	2.0	0.8	${}^{16}\text{O} + {}^{16}\text{O}$
Si, S	Fe	Ti, V, Cr, Mn, Co, Ni	3.5	0.02	${}^{28}\text{Si}(\gamma, \alpha) \dots$

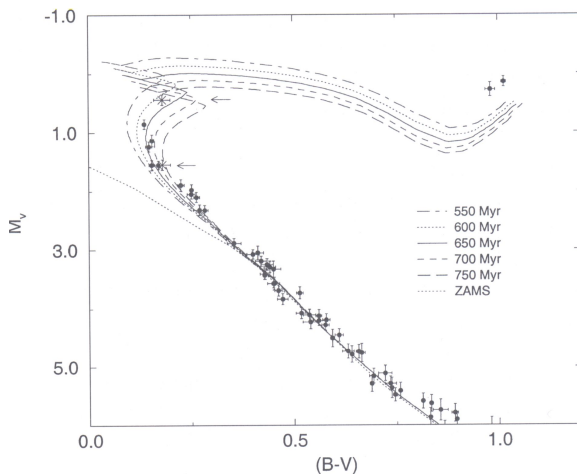
HRD and Stellar Age



Colors - Filters



Cluster Ages



Hyades cluster and stellar tracks

Evolution tracks and lifetimes

