

Extragalactic Astronomy and Cosmology Stellar Stages

Stars lighter than about 8 solar masses

Name	Size	Core	Time
Molecular Cloud	Huge*	(none)*	arbitrary
Protostar	Large	Hydrogen	0.1 Gyr
Main Sequence	Small	Burning Hydrogen	10 Gyr
First Giant Branch	Large	Helium	0.5 Gyr
Horizontal Branch	Medium	Burning Helium	0.4 Gyr
Asymptotic Giant Branch	Large	Carbon/Oxygen	0.1 Gyr
Planetary Nebula	Shrinking	Carbon/Oxygen	10,000 yr
White Dwarf	Tiny	Carbon/Oxygen**	forever

* - a molecular cloud typically becomes many stars. It is not really a stage.

** - only the core remains

All times are for a one solar mass star. Bigger stars go faster; smaller stars go slower.

Heavier stars become Type II supernovas, and then become neutron stars

Very heavy stars become black holes

Spectral Classes vs. Temperature

O5	B0	B5	A0	A5	F0	F5	G0	G5	K0	K5	M0	M5	M8
40,000	28,000	15,500	9900	8550	7400	6600	6050	5550	4900	4150	3500	2800	2400

The History of the Universe

<u>Time</u>	<u>$k_B T$ or T</u>	<u>Event</u>
10^{-43} s	10^{18} GeV	Planck Era; time becomes meaningless?
10^{-39} s	10^{15} GeV	Inflation begins; forces unified
10^{-35} s	10^{14} GeV	Inflation ends; reheating; forces separate; baryogenesis (?)
10^{-13} s	1500 GeV	Supersymmetry breaking, LSP (dark matter)
10^{-11} s	160 GeV	Electroweak symmetry breaking
14 μ s	150 MeV	Quark Confinement
0.4 s	1.5 MeV	Neutrino Decoupling
1.5 s	0.7 MeV	Neutron/Proton freezeout
30 s	170 keV	Electron/Positron annihilation
200 s	80 keV	Nucleosynthesis
57 ky	0.76 eV	Matter-Radiation equality
370 ky	0.26 eV	Recombination
0.6 Gy	27 K	First Structure/First Stars
13.8 Gy	2.725 K	Today