Astro 358/Spring 2006

(48915)

Galaxies and the Universe

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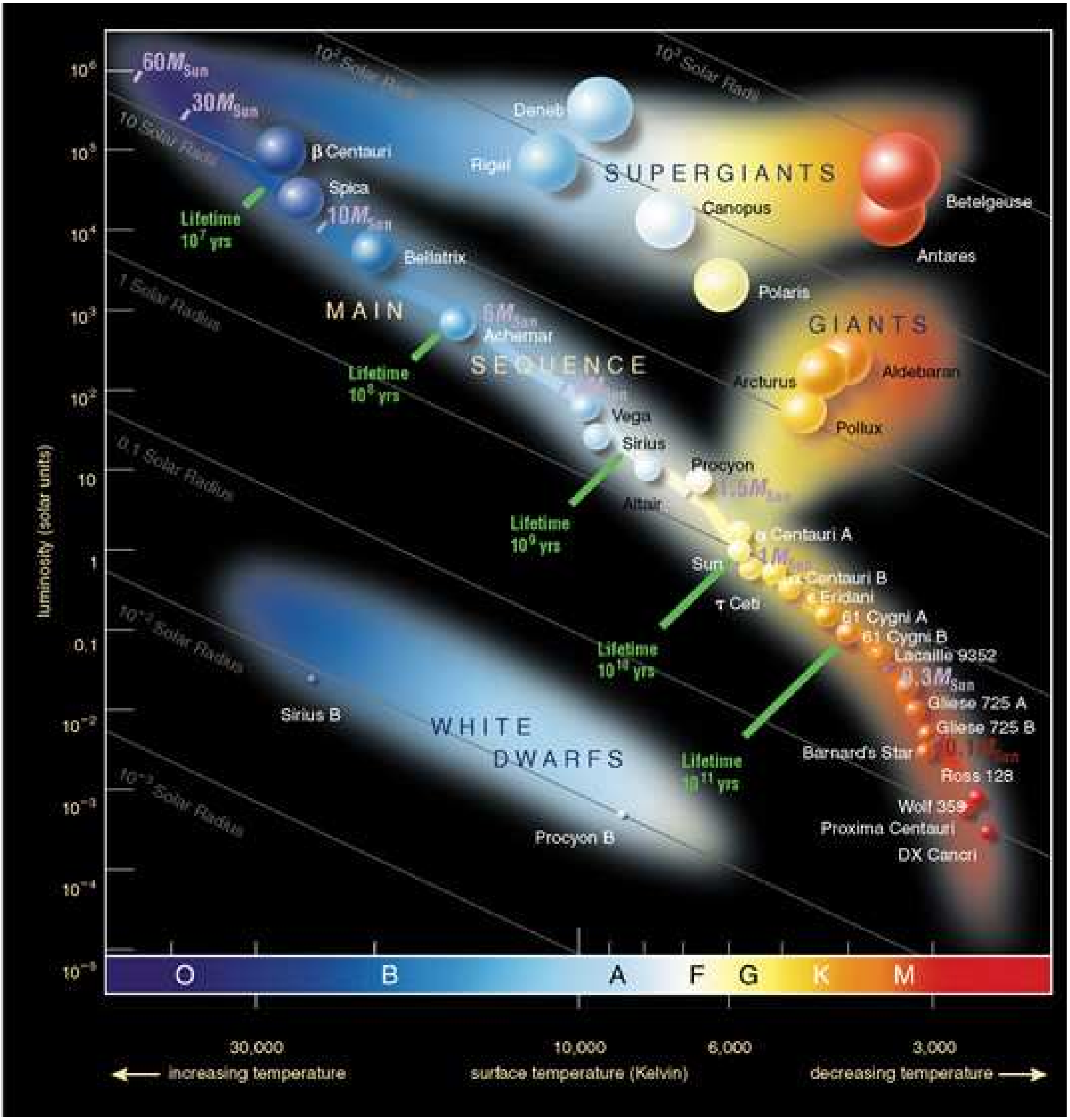
TA: Ben Holder

Figures/Images

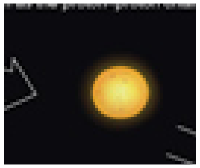
Lecture 3: TuJan 24

Evolution of high and low mass stars

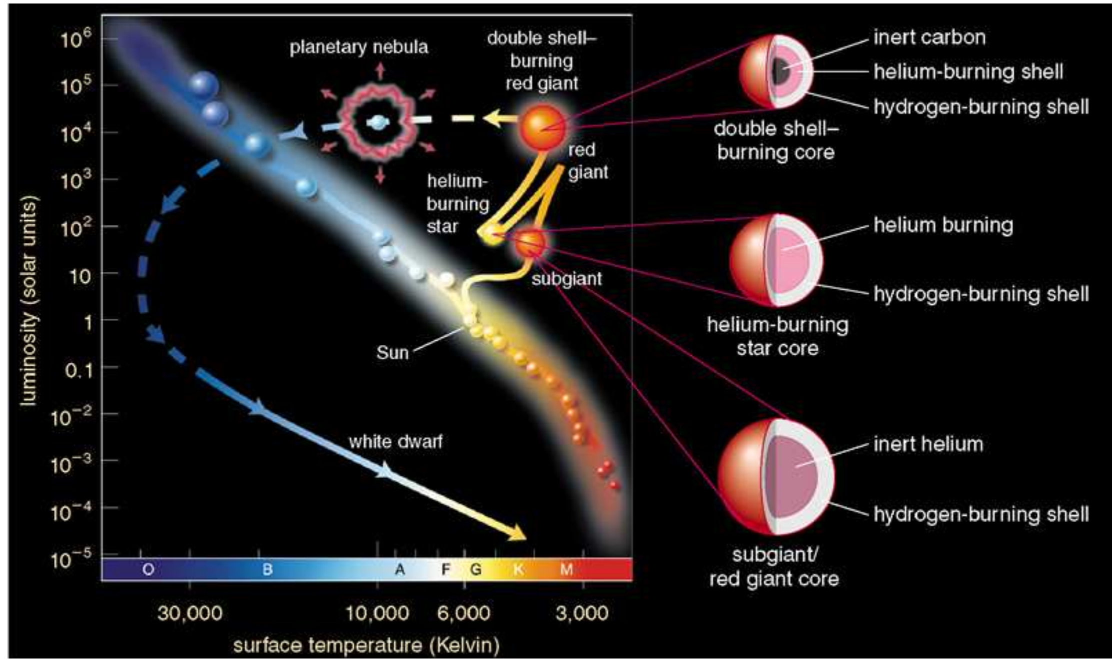
Hertzsprung-Russell (H-R) diagram

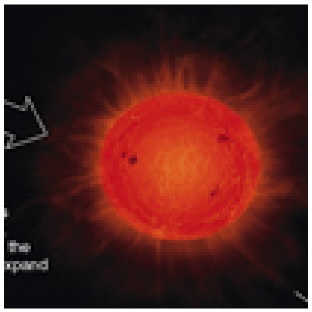


Evolution of low-mass stars

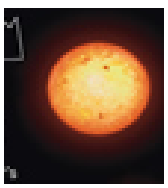


Yellow main sequence star.
H fusion in core via pp cycle

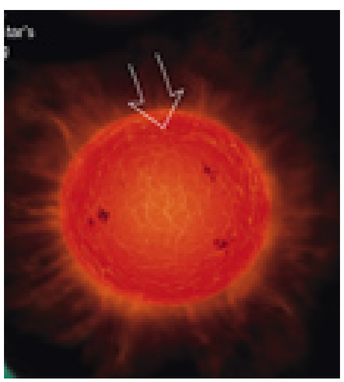




Red giant:
Inert He core
H-burning shell

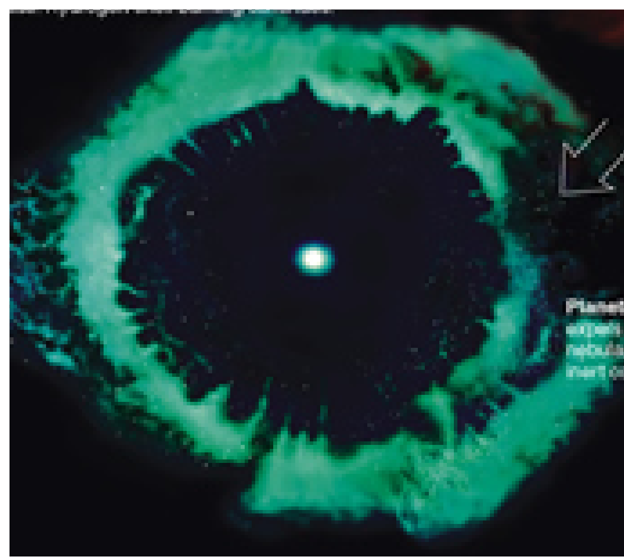


He-burning core + some reduced H-burning in shell



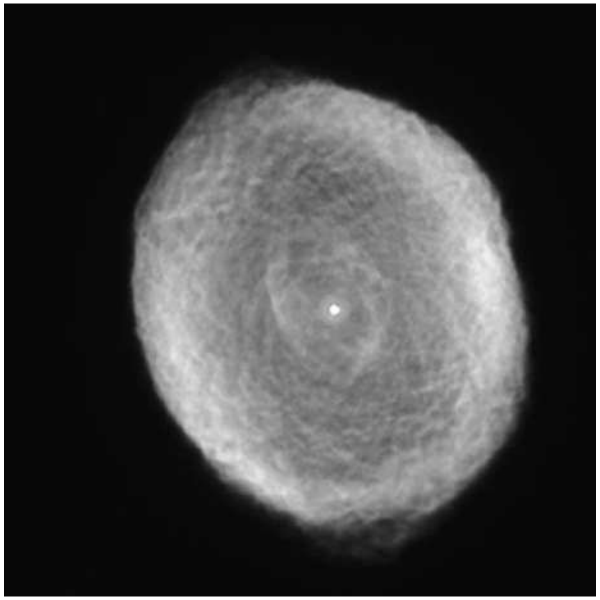
Second red giant phase.
Inert C core + double shells burning He, H

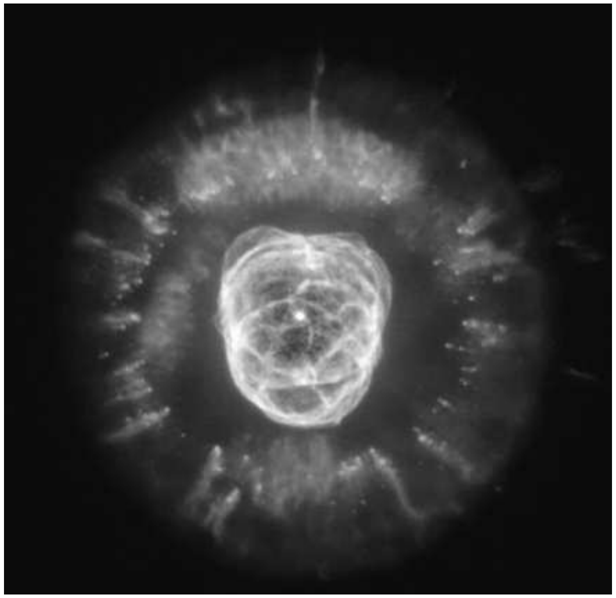
Planetary nebula

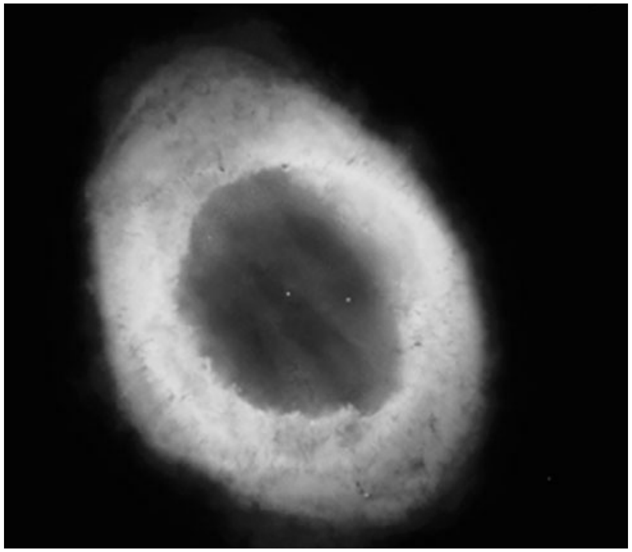


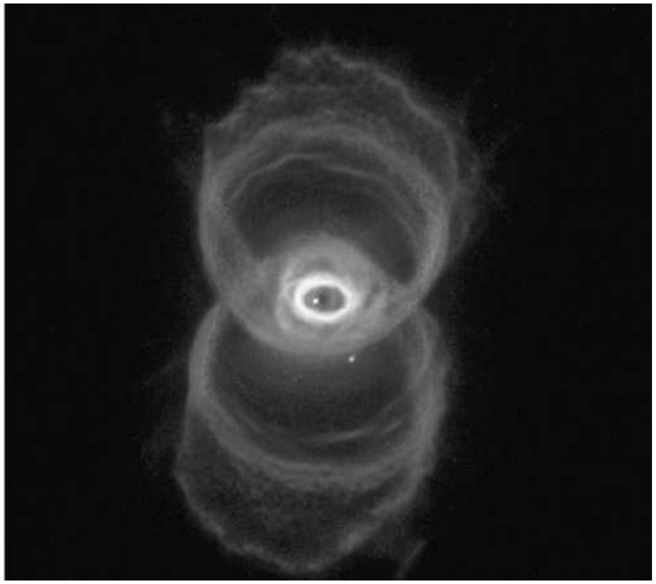
White dwarf

Evolution of low-mass stars: Planetary Nebulae



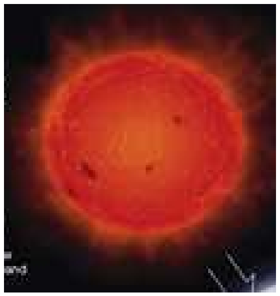






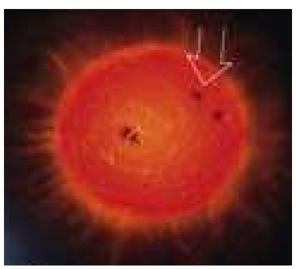
Evolution of high-mass ($M>8M_o$) stars

Blue main sequence star. H fusion in core via CNO cycle

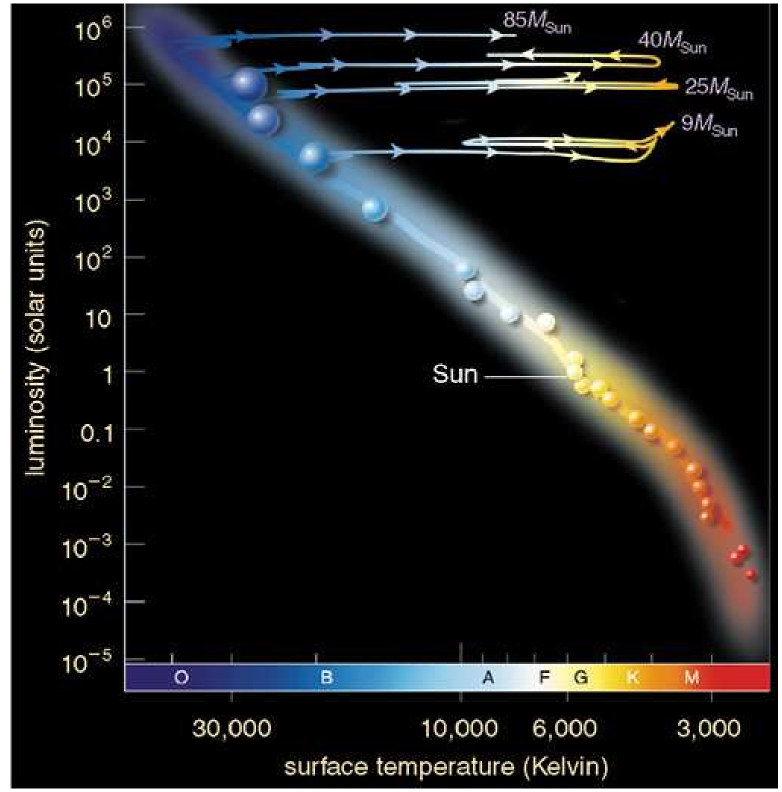


Red supergiant:
Inert He core
H-burning shell

'Blue' supergiant:
He-burning core +
reduced H-burning
in shell

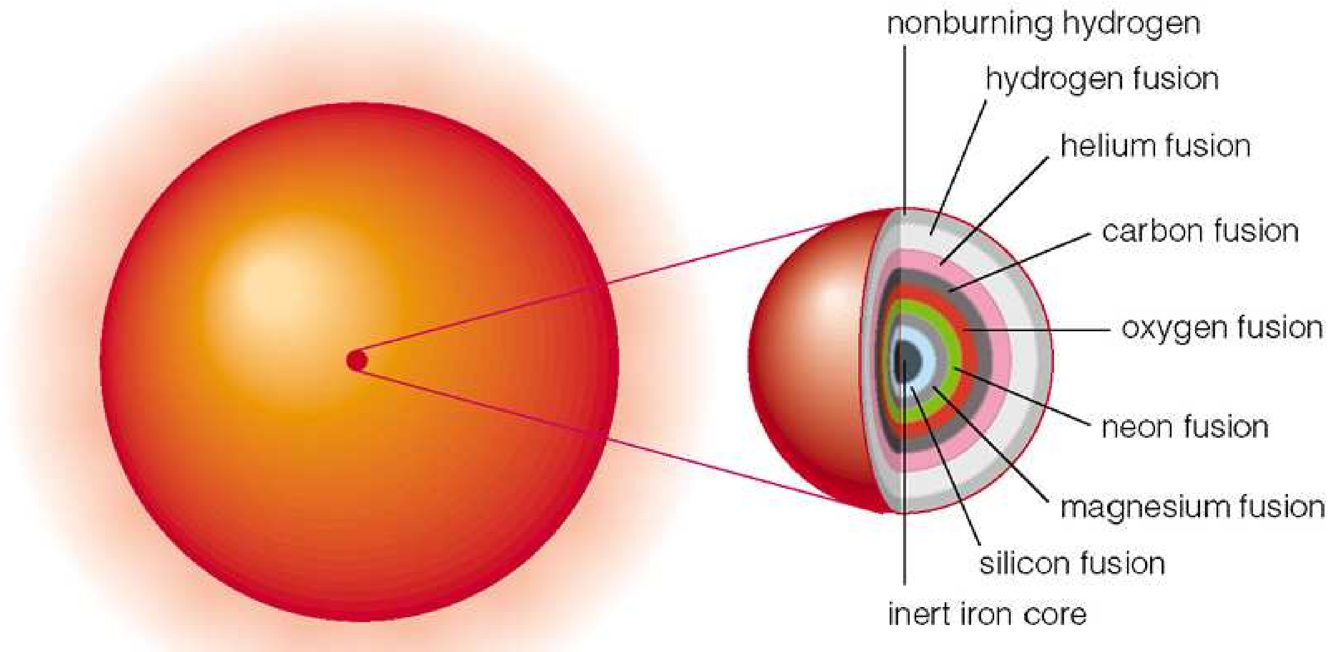


Supergiant phases. Inert C core shrinks till fusion of C starts, then of O, then…of Si until iron collects in core. Multiple shells burning C, O, He, H

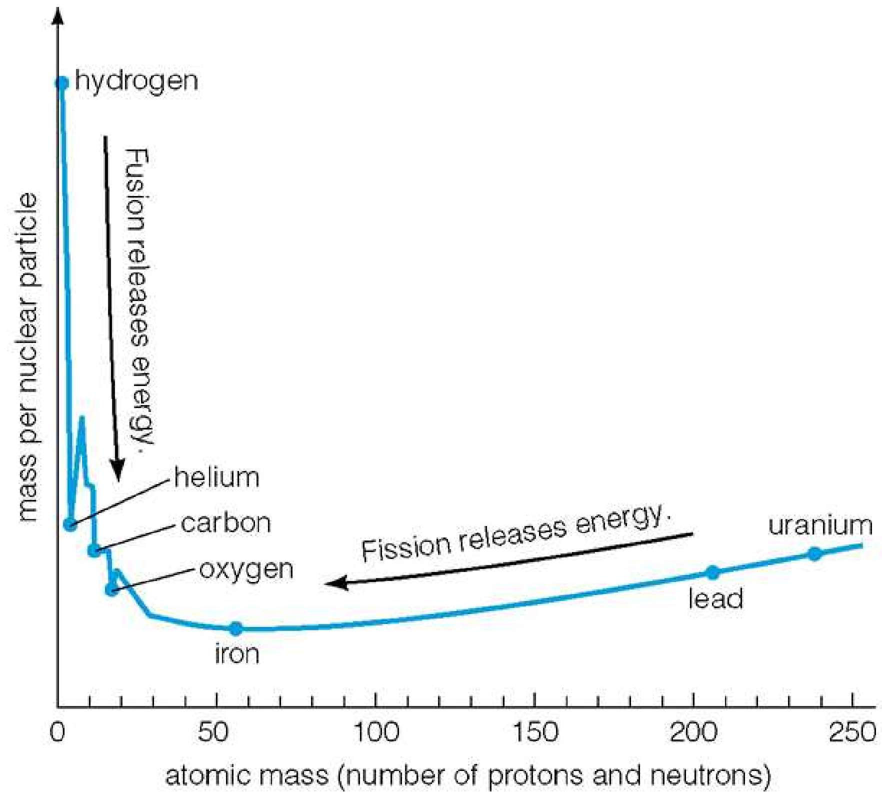


When it is no longer supported by deg-pressure, iron core collapses, and e- p+ combine to form a neutron star or BH. Star explodes outer layers into SN

Evolution of high-mass stars



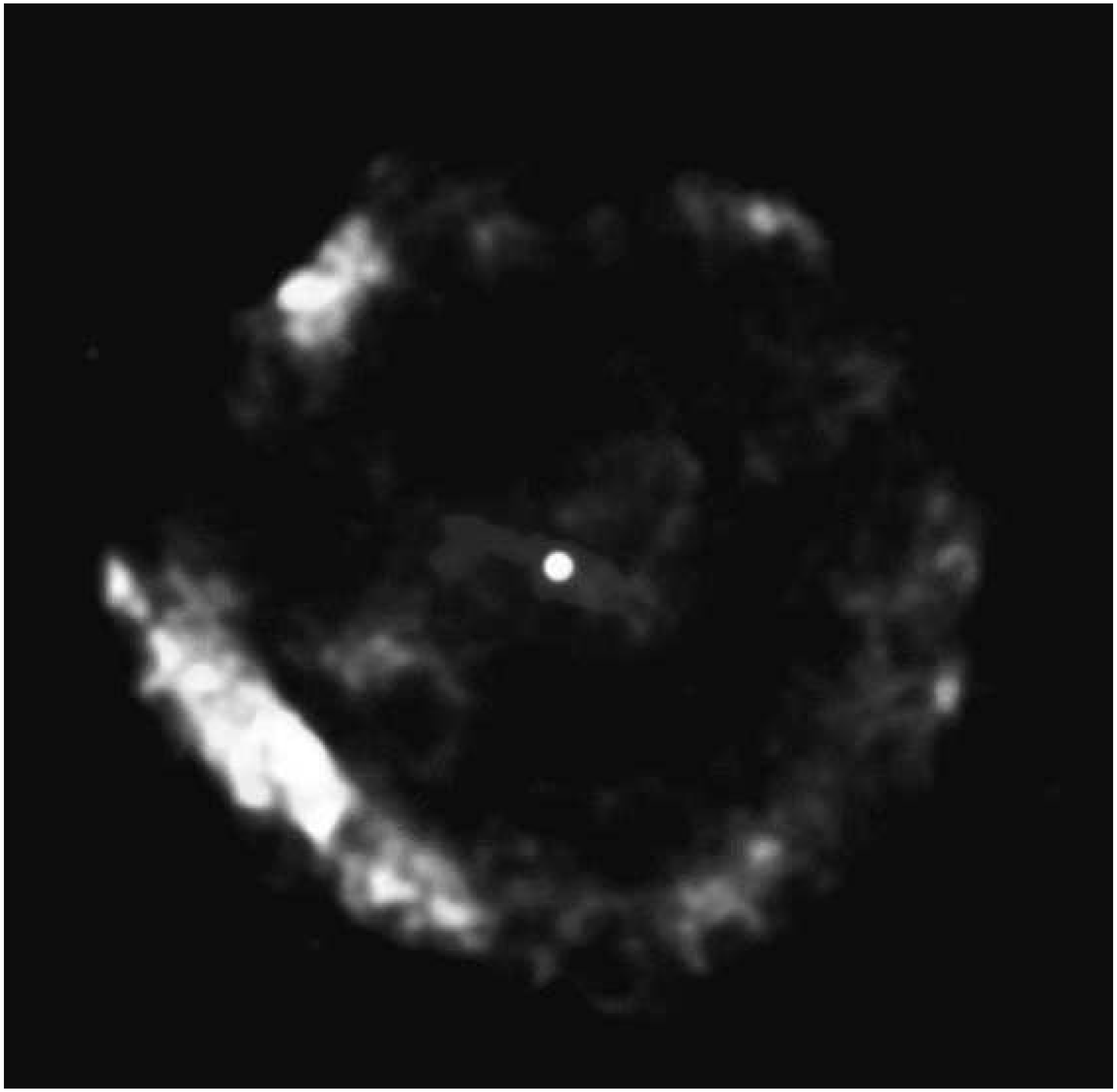
Energy generation by fusion and fission of elements heavier than H



Evolution of high-mass stars

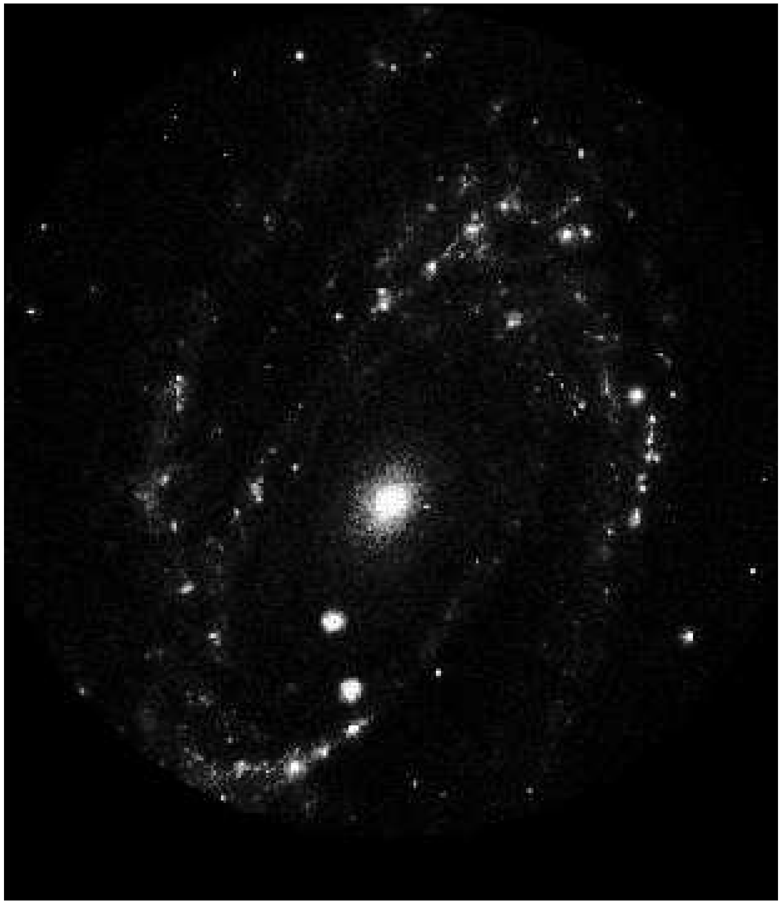
Visible image of the Crab nebula Supernova remnant in constellation Taurus

Evolution of high-mass stars



X-ray image from CXO of a neutron star at center of old supernova remnant

Sites of massive and low mass stars in M81..



Ultraviolet/ASTR0-1

UV Peaks = Site of hot massive stars
= sites of recent star formation within
the last 20 Myr

Optical image

Peaks in optical yellow light
= Site of solar mass T~6000 K stars
= sites of low mass, long-lived stars

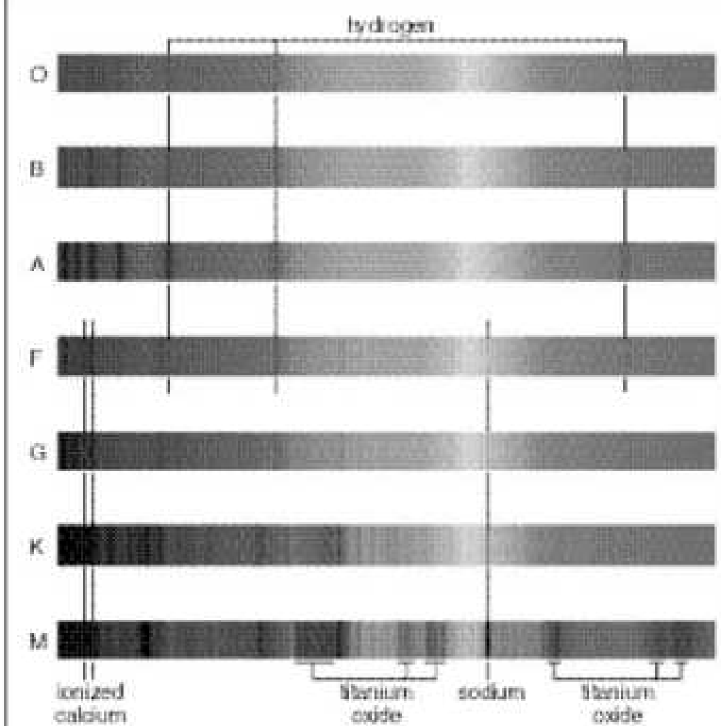
MK classfication system for stars

Spectral Type of Stars in MK or Harvard system

Table 16.1 The Spectral Sequence

Spectral Type	*Example(s)*	*Temperature Range*	*Key Absorption Line Features*	*Brightest Wavelength (color)*
O	Stars of Orion's Belt	>30,000 K	Lines of ionized helium, weak hydrogen lines	<97 nm (ultraviolet)*
B	Rigel	30,000 K–10,000 K	Lines of neutral helium, moderate hydrogen lines	97–290 nm (ultraviolet)*
A	Sirius	10,000 K–7,500 K	Very strong hydrogen lines	290–390 nm (violet)*
F	Polaris	7,500 K–6,000 K	Moderate hydrogen lines, moderate lines of ionized calcium	390–480 nm (blue)*
G	Sun, Alpha Centauri A	6,000 K–5,000 K	Weak hydrogen lines, strong lines of ionized calcium	480–580 nm (yellow)
K	Arcturus	5,000 K–3,500 K	Lines of neutral and singly ionized metals, some molecules	580–830 nm (red)
M	Betelgeuse, Proxima Centauri	<3,500 K	Molecular lines strong	>830 nm (infrared)

Typical Spectrum



Spectral Type of Stars in MK or Harvard system

Stellar Atmospheres by Dr Cecilia Payne, Harvard, 1925
… “Most brilliant PdD thesis in 20th century”