

Birth and Life of Stars

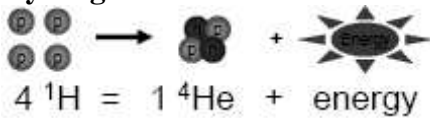
Dr. Jennifer Coy

How does the sun shine?

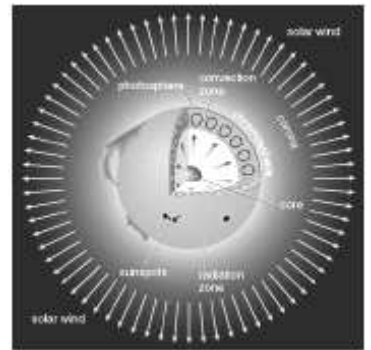
- The Greeks suggested: could the energy comes from burning coal?
 - Problem:

- In the mid-1800's, it was suggested: could gravitational contraction provide the energy?
 - **Gravitational contraction:** *as gravity compresses material, its temperature increases.*
 - Problem:

- Could it be **fusion**?
 - Requires enormous heat and pressure
 - **Hydrogen fusion:**



- Solution?

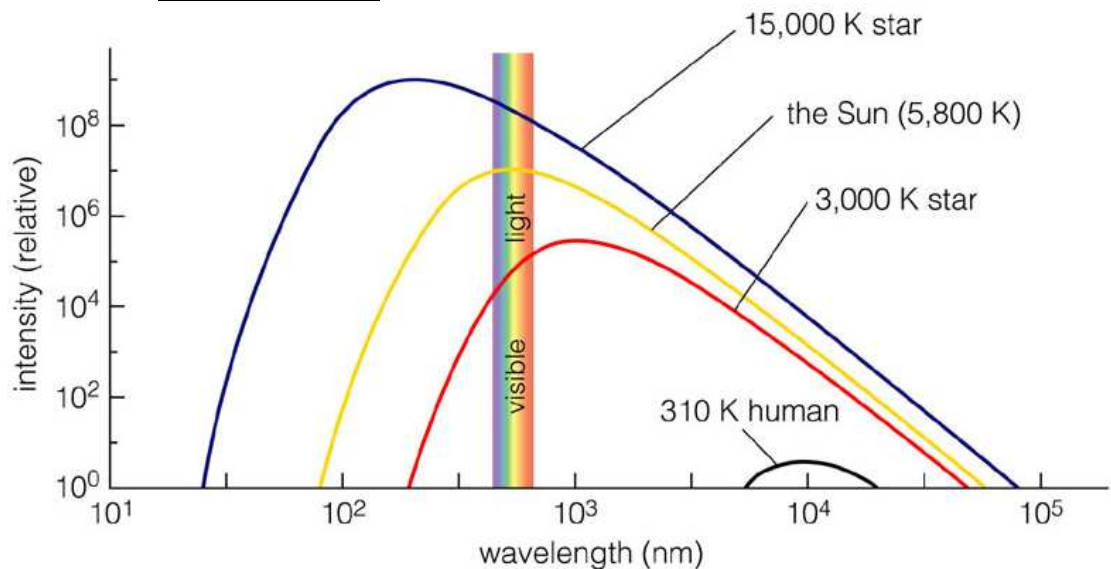


How does this energy get out of the Sun?

- Fusion occurs in the _____ of the Sun
- Energy transferred from core to outer layers by _____
- Energy transferred near surface by _____
- Energy transferred from surface of Sun to Earth by _____

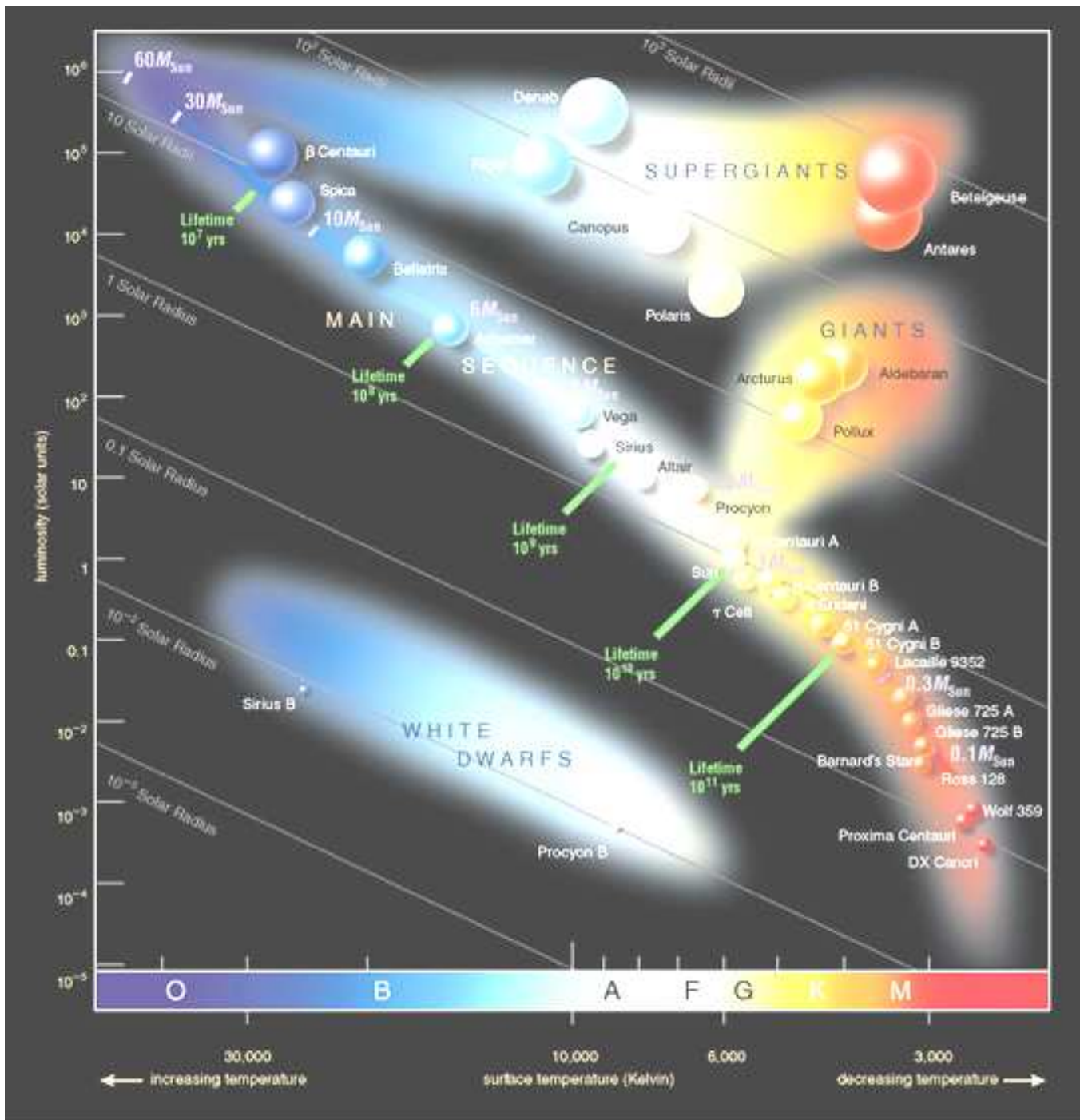
Looking for patterns in the stars

- **Temperature vs. Color**
 - More Blue = _____
 - More Red = _____



- **Hertzsprung-Russell (HR) diagram:** a periodic table for the stars, show:

- Hotter = brighter/dimmer = bigger/smaller = blue-white/red
- Cooler = brighter/dimmer = bigger/smaller = blue-white/red



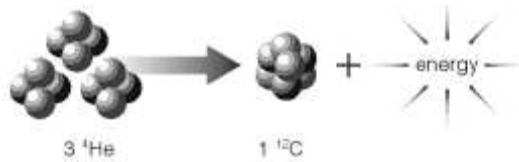
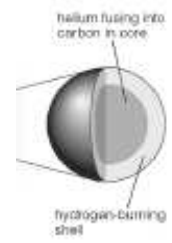
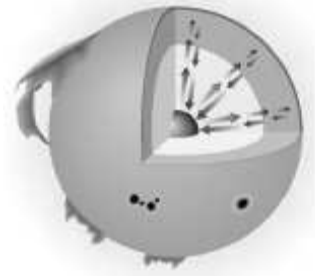
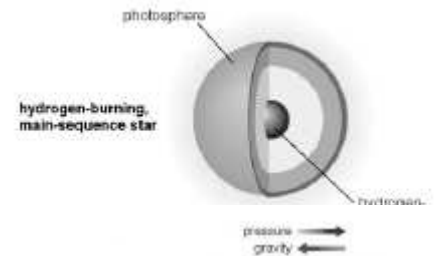
Life Cycle of Stars: Birth

- Nebula: a cloud of dust and gas
- Theory of Star Formation:
 1. Nebula begins contracting under influence of gravity
 2. Begins to spin
 3. Gravitational contraction causes central portion to heat up
 4. Protostar continues to contract under gravity, and continues to heat up
 5. When the core reaches about 10,000,000 degrees, fusion begins.
 6. A star is born!

• The Theory of Star Formation predicts: And we observe:

Life Cycle of Stars: Life and Death

- Life cycle depends on the _____ of the star
- **Low Mass Stars**, like the Sun
 - Undergo Hydrogen fusion in core for about _____ years
 - When Hydrogen in core is depleted, the balance between _____ and _____ is disturbed
 - This causes the outer layers to expand, and the star becomes a _____
 - Star will begin to shrink, causing temperature to increase in core.
 - _____ fusion will begin in a shell around the core.
 - For massive enough stars, the core can heat up enough to sustain _____ fusion.



- This state can only be maintained for about _____ billion years.
- Once Helium runs out in the core, the star expands, and a _____ forms, and the process can begin again.

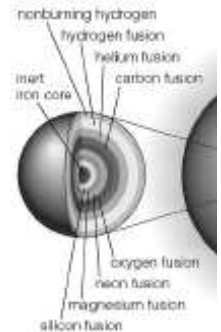
Implications for Life on Earth

- What will happen?

- Do we need to worry? Why?

Life Cycle of Stars: Life and Death

- Life cycle depends on the _____ of the star
- **High Mass Stars**
 - Early stages are similar, but progress faster:
 - H fusion
 - H shell-fusion
 - He fusion in core
 - Higher mass means that _____ can cause higher temperatures.
 - Shell fusion occurs in onion-like layers.
 - The star expands to become a _____ Star.
 - The core becomes filled with _____, the one element from which it is not possible to generate any kind of nuclear energy.
 - Fusion in each shell slows, gravitational pull compresses the Iron core.
 - When the Iron core is about equal to the mass of the _____ but the size of the _____, its own intense gravity causes it to collapse into a ball only a few miles across, consisting of only _____.
 - This releases huge amounts of energy, known as a _____, which produces a nebula, where the process can begin again.



The Periodic Table of the Elements (see next page)

- Which elements are formed in the Big Bang?

- Which element is made by Helium fusion in low-mass (and high-mass) stars?

- Which elements are made in the shell-fusion phase of high mass stars?

- Which elements are made only in Supernovae?

Periodic Table of the Elements

1A	1	H	2A	2	He																
	3	Li	4	Be	5	B	6	7	8	9	F	10	Ne								
	11	Na	12	Mg	13	Al	14	15	16	17	Cl	18	Ar								
	19	K	20	Ca	21	Sc	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	37	Rb	38	Sr	39	Y	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
	55	Cs	56	Ba	*La	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
	87	Fr	88	Ra	+Ac	104	105	106	107	108	109	110	111	112	113						

* Lanthanide Series

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

+ Actinide Series

90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr