VI. Origin of the elements and formation of the solar system

6.1 Looking outside the Earth

We can observe the chemical composition of the earth's crust, and we know from geophysical data that the crust is much less dense than the earth as a whole. The crust is thus not representative of the mantle and core.

To gain additional information, consider the formation of the earth and solar system: the geology/astronomy overlap area.

Questions-very fundamental (though often not needed on day-to-day basis in earth science: akin to foundation of house)

1) How were the elements (material) of solar system formed?

2) How did this stuff form into the solar system?

3) How did individual planets form?

4) How did the planets evolve into their current state?

If we knew the answers to these questions we would know a *lot* about the the compostion and structure of the earth!

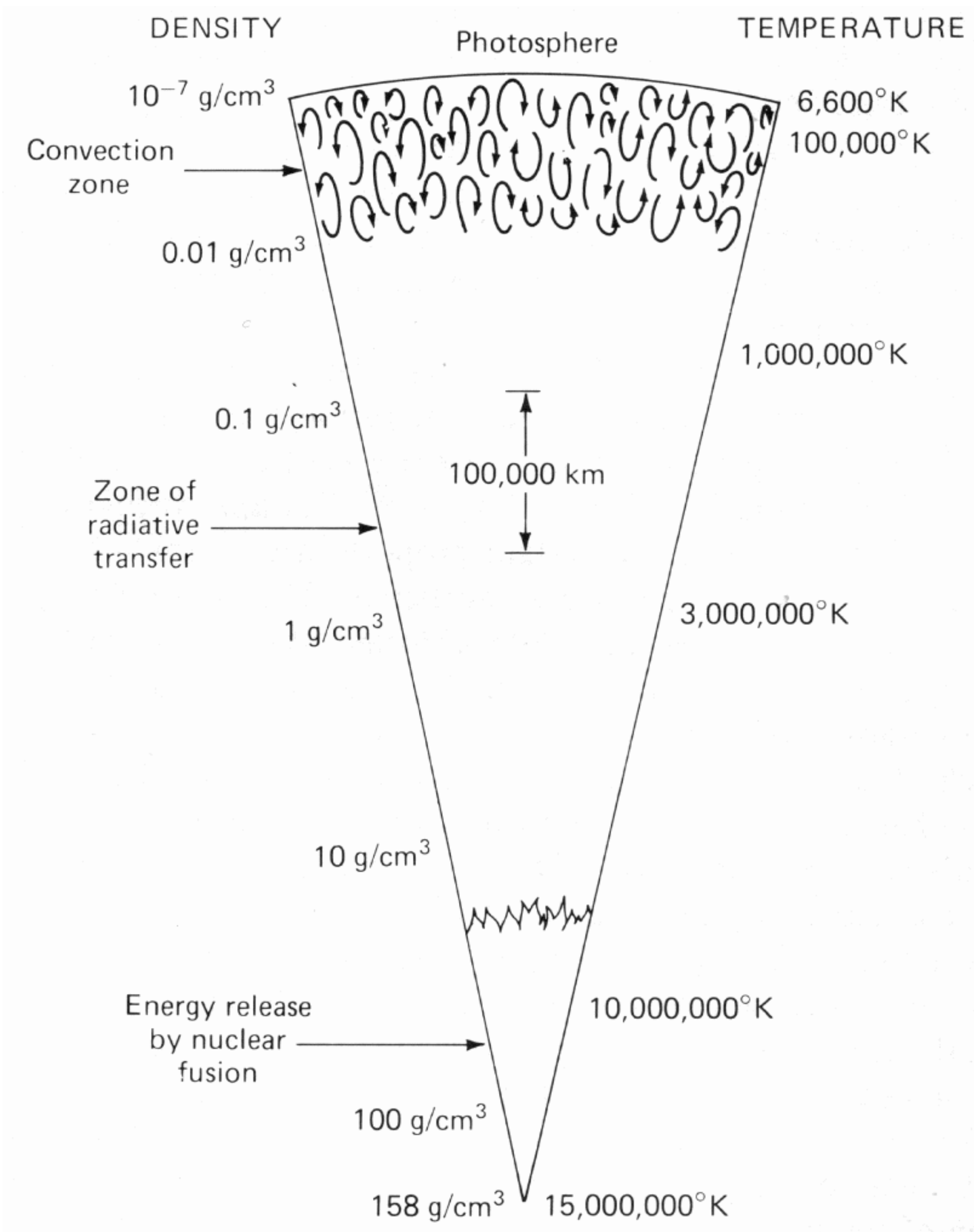
Each question is complicated, only partially understood, and worth several courses in itself.

We'll summarize a few basic ideas about each one very superficially-if only for the fun and for the awareness of how much we have left to learn...

6.2 The Sun

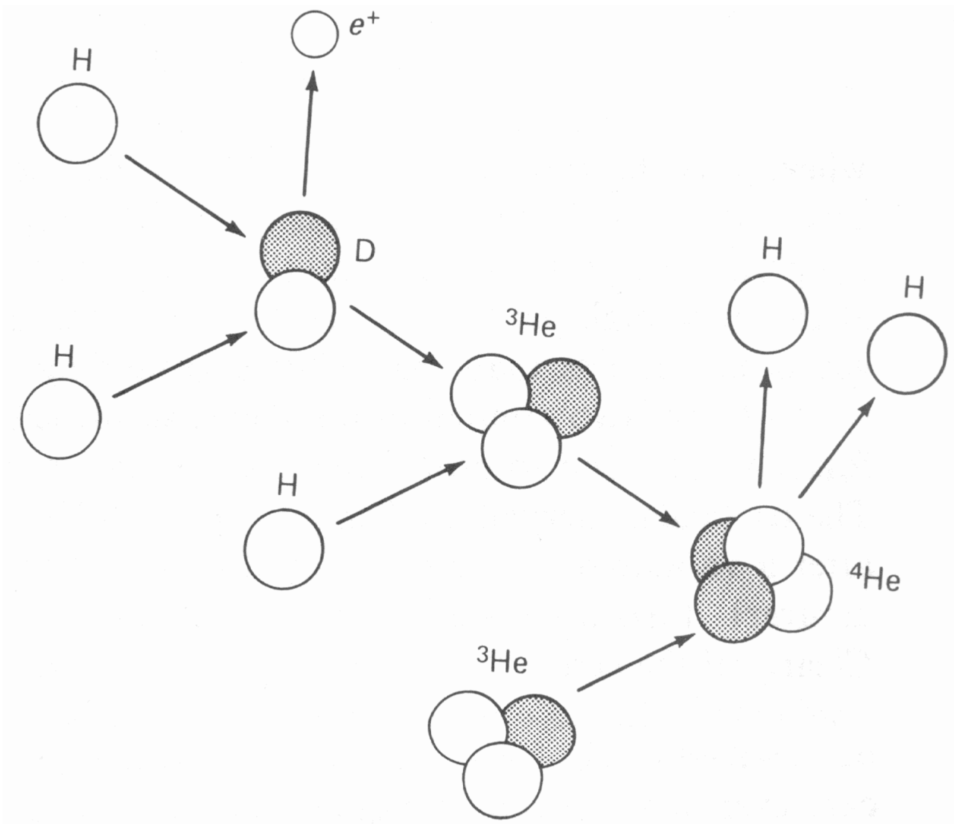
6.2.1 Model of the solar interior

The sun has 99.9% of the total mass: its pretty important! What's its composition? From orbit calculations its average density is 1.4 gm/cm^3 but its moment of inertia factor $\frac{I}{Ma^2}$ = .06! So it's very concentrated in mass toward the middle (remeber - earth is .33)



6.2.2 The energy-producing reaction in the sun

The nuclear fusion reaction is called a "proton-proton" or "hydrogen-burning" reaction - multiple stages



(1) Two hydrogen nuclei (protons) combine to form a deuteron - a hydrogen isotope of atomic weight 2. To do this they emit a positron (positive electron) making one proton into a neutron.

(2) A second proton combines with deutrerium to form helium-3.

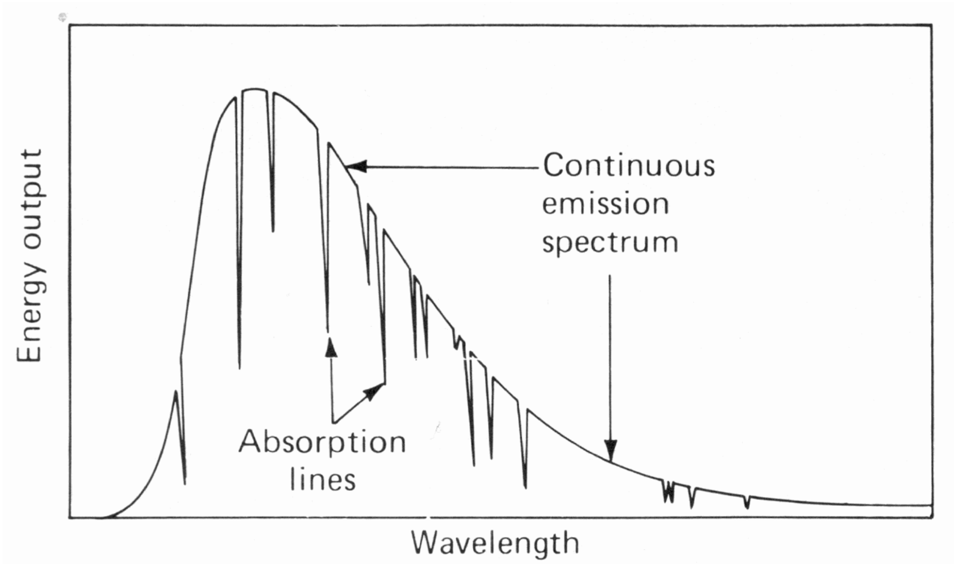
(3) Two helium-3 nuclei fuse into helium-4 releasing energy +2 protons.

The reaction gives off lots of energy-its the H-bomb reaction. Why?

Why, then doesn't fusion occur spontaneously (hate to have everything turn spontaneous into H-bombs)? The protons repel each other electrically - so they have to have VERY high energy to overcome this repulsion and fuse. This only happens for temperatures > 2 x 10^7°K (20 million!). (For this reason an H-bomb requires an A-bomb to trigger it).

6.2.3 The composition of the sun

The composition of the sun is found from SPECTROSCOPY-looking at the wavelengths of light emitted (conceptually-like using a prsim)



So-the sunn is about 70% hydrogen, 28% helium and about 2% everything else.