Astrophysics- I (a)

Lecture-1

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Radius of Sun

The radius of Sun is 696000 kilometres and that's about that's over a hundred and ten times the size of the earth which the earth is about 6371 kilometres and so 601 hundred and ten Earth's fit across the Sun and if you multiply it out about a million earths could fit inside the Sun and you can see in image of Sun in PPT slide there's a little tiny dot next to the Sun on the that would be what the earth would be if it were traveling that close luckily the earth never gets that close to the Sun so it would be burned up and it's quickly fall in so the earth is very very very tiny compared to the Sun and huge prominences of which are gas clouds such as you see in this image get lifted off the Sun and there are incredibly large they average structures that move very rapidly so the radius of the Sun is big and it carries a characteristic size scale for stars so comparing about how big stars are how small stars are and the size is about a hundred times the size of the earth which is a typical stellar size all right so when we look at the complainants in comparison we can see that the planets are pretty small compared to the Sun Jupiter even the king of the planets which is ninety percent of all of the mass of all the planets is in Jupiter and it's not really it's only about ten times smaller than the Sun in terms of in terms of diameter but earth is the earth is about a hundred times smaller in terms of diameter.

Mass of Sun:

The mass of the Sun is extraordinarily big numbers so the mass of the Sun or M sub Sun is about 2 times 10 to the 30th kilograms and so for those that are math disinclined at that X is 8 times the 10 to the 30th is a is a 1 with 30 zeros after it so it's a 2 times 10 to the 30th or basically a number 2 with 30 zeros after it that's enormous now the mass of the Earth is about 6 times 10 to the 24th kilograms so the if you wanted to put them on a balance it would take about a third of a million Earth's to balance the mass of the Sun so the Sun is much is more massive than anything else in the entire solar system including the earth all right.

Average Density:

The average density the average density is you take the mass of the Sun and divide it by its volume and the average of all mass of the Sun is what works out to be compared to its volume is about 1,400 kilograms per cubic meter that's how we can read that so sub Sun or density sub Sun is about 1.4 kilograms per cubic meter water is about a thousand kilograms per cubic meter and the Earth's average density is about 5,500 kilograms per cubic meter so the Earth's average density is much more dense than the Sun so therefore but the Sun is much more massive so there must be something a little bit weird maybe down in the core something's happening and so but the average it's not the same density at the core t's not the same density at the surface there the sun's density varies wildly whereas the Earth's average density by comparison doesn't vary as much as the sun's

Composition of the Sun

What is the Sun made out of well it cement 70% of it by mass is hydrogen which is just a proton we can ignore for now the electrons because the electrons are much are very very tiny compared

to the protons and by mass the helium nuclei make up about 28% of the Sun and about 2% are heavier elements heavier than hydrogen helium so oxygen nitrogen carbon neon or on uranium iron everything you can think of everything else from the entire periodic table that makes up only about 2% of the mass of by mass of the Sun and that's why it's the average density so low because hydrogen is a single proton the average density most of what Earth is made out of is made out of silicon and oxygen makeup so to make up silicon dioxide or things rocks so rocky materials that such as carbon oxygen nitrogen iron the heavier elements the earth is doesn't have as much hydrogen or helium as the Sun by comparison so therefore the earth has less well that's the surface composition of the Sun the composition changes as you go deeper into the Sun but in general the if you were to average doll out by mass the total mass is at the surface and 70% hydrogen 28% helium all right so that'll tell that tells us something very interesting and how do we know that the sun's composition is this that's really critical so because has anybody been to the sudden no nobody has ever been to the Sun dome was ever scooped up anything from the Sun so how do we do it we do it with spectroscopy which we talked about before and we will talk about soon all right so the average composition in terms of numbers of atoms so we can then say instead of just by mass we can say the numbers of atoms which is a different sort of concept of the density of it um we see here that my atoms hydrogen makes up almost ninety percent or roughly 90 percent of the number of atoms of the Sun which means it's 91% just protons zooming around and about 9% a helium nuclei just running around which a typical helium nucleus has two protons and two neutrons and everything else is so much less by the total number of atoms the entire Sun is almost completely made up of just hydrogen and hydrogen is not so massive so therefore the mass is lower and helium is more massive. you know there's four printers for objects in the core rather than just one and in the nucleus rather than one so there for helium being only 8% of the total of nine percent it's only multiplied by four and you get really close to the total mass of that but why isn't it four times nine which would be 36 and that's because a significant fraction of the helium is sending form of tritium which is not tritium which is light helium sorry light helium which is helium-3 which only has one Neutron not two so but of all the rest oxygen carbon nitrogen silicon magnesium diode sulfur and those are the big ones and notice what it's made out of oxygen and carbon are critical for life pretty much everything in there is critical for life except for neon so what's interesting these are really really interesting things that the Sun is made out

Rotation of SUN:

How does the Sun rotate there's another bulk thing well we can measure the speed with which sunspots go around other throughout the Sun and we find that at the high latitudes it's moving a lot slower than at the equator so it actually rotates a lot faster at the equator than it does at the poles so it's interesting and inside it rotates a different rate altogether and that can be measured by what's called astros a stereo seismology or helioseismology looking at the roadie well it's interesting that also that's that that last one over the 27 days inside is also strongly modelled dependent meaning what is happening in the core of the Sun and how does how do things change as they come out but it also can be indirectly measured by looking at the vibrations or ringing or waves on the surface of this well the real trick is what we find is that simply because we see that happening the Sun is not a solid there is no solid surface to the Sun as the Sun rotates it twists itself up it's a big ball to gas there's no place to land on there's no hard surface it is gas all the way down to the centre.

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