Astrophysics- I (a)

Lecture-2

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Magnetic Field of Sun:

The magnetic field of the Sun is ten thousand times more powerful than the Earth's magnetic design and all of the features that you see on the surface of it these but these bright spots in image of sun these are hot spots they prominences flares everything all of the surface features are driven by the strong magnetic field of the Sun and that strong magnetic field is what it does is that if a charged particle such as a proton without any nuclear with an ionized proton is on the magnetic field it will follow the magnetic field line so little electrons and so what you can see in that upper right-hand corner of the prominence is ionized gas that's being lifted off of the surface as the magnetic field changes and the magnetic field changes a lot. It's flexible and fluid as a thing and it originates and one of it's the source of what we call space weather and space weather is the thing that affects satellites around Earth and can cause power outages here on the whole ground.

Surface Temperature of Sun:

What's the surface temperature of the Sun it's almost 6,000 Kelvin, T sub Sun is almost is about 5800 Kelvin and that's hot or anything you find some things did you'll find that are that hot would be maybe special bulbs of light that you might see in a theatre. That's funny is that well is the Sun burning and if it's something is that hot you'd expect it to be burning but the answer is no the sun's not burning because what is burning is the combining is the rapid combining of oxygen with something made of carbon or and to produce carbon dioxide and it is the rapid change of chemical structure inside of something such that gases are released but since it's a fast oxygenating process that's what burning is and you only get burning when there's oxygen well there's not a lot of oxygen on the surface of the Sun as we teach as we've learned so why does the hydrogen glow why does the helium glow it glows because it's really hot and anything doesn't matter what it is it can be a solid it can be a liquid and there's a gas in this case a gas can be so hot and so dense that it delighted that it just simply glows now that's fascinating so the hot it is more like the glow of molten iron ore but the sun's not molten it's a gas so molten still like a solid that kind of moves it's a fluidic solid that's molten iron or flowing iron which is sight which is a liquid state of iron but when we think about this it's like the sun's not a liquid it's a gas it's not a solid so it's in a state of gaseous nests and there's no crystalline structure to make up the Sun of any kind so it's just a hot glowing gas that's not burning all then we say well if it's hot.

Luminosity:

What is the energy output and the energy output is what we call luminosity of the Sun, sub Sun is a standard that we'll see all throughout lecture it's about four times ten to the 26th watts and that's the same as ten billion one Megaton nuclear weapons exploding every second now how many make one Megaton nuclear weapons do we have on the surface of the earth at the height of the Cold War it was on the order of a few thousand so you know or ten or ten thousand or so basically there were there's more happening in the centre of the Sun then all the nuclei maybe half a million times the total number of nuclear yeah it's like okay half a million is about 500,000 and you take roughly 10,000 or so nuclear bombs that were made of been or about one Megaton or half Megaton or kiloton nuclear weapons multiply out the total constructed number of nuclear weapons that have ever been constructed by the entire human race in its entire existence since we started building them in the 1940s and detonating them you'd have to have a hundred thousand of those things in those sets of nuclear bombs that have ever been constructed the most terrifying weapons too to equal what the Sun does every second Wow and that's more than we do in all in this wattage the amount of wattage that the Sun puts out every second or four joules per second that's what 1 watt is 4 times 10 to 26 watts that's more energy that's being put out per second than has been put out in the entire history of all they recorded industrial since the Industrial Revolution and that's what's happening every second it's a lot of energy output all right so the energy output that's fiducial value L sub Sun which is 4 times 10 to the 26 watts we will see it again and again and again inside this and the solar constant is what we get from the Sun so the Sun goes out the Alta sunlight goes out in every direction and at one astronomical unit away or 93 million miles away or 1 and 150 million kilometres or million meters 150 million yeah 150 billion meters it is 150 kiloton million kilometres, what we get and that's equivalent to 13 normal lightbulbs on a kitchen table so take a standard desk like you might get and a standard work desk is about a meter a square meter it's about a meter squared and so imagine you take 13, 100 watt light bulbs and put them on your kitchen table and then put your face right next to all those things that's what the Sun is putting onto the surface of every square meter on the surface of the earth at the distance of one astronomical unit that's what we get that's what you get that's what every place gets that's one astronomical unit away whether it's above the Sun below the Sun behind the Sun to the left of the Sun to the right of the Sun there's just intersects a tiny tiny tiny fraction of all of that all of that output and what we call that wattage per square meter at the surface of the earth we call that the solar constant and the solar constant is the wattage that is received on the surface of the earth per square meter and that's it's an amazing amount of energy if you really think about it so imagine you take 13 normal light bulbs per square table imagine we hooked up light bulbs basically every 12 inches on the surface of the earth a hundred watt light bulb and then turn them all on that's what we would have to do in order to equal the sun's output that we receive on earth every second.

What kind of star is the Sun?

If we take the star the light from the Sun and pass it through a prism and then compare it to other stars what we find is that the Sun is like what we call a g-type star and specifically it is a g2 which means it's a little bit cooler than a g0 and it is a main-sequence type star or a g25 type star and that's what we call that so if we compare the Sun spectrum to other nearby stars we find that Alpha Centauri one of the nearest stars to us in the sky is actually just like the Sun. It's about three light-years just a little bit about 4 light years away and it's one of the closest stars to us and it has the same exact spectral signature is the Sun so that's kind of cool so where does the light from the Sun come from and that is really the biggest question of all and that's how the Sun produces the light that it makes and how long will it be able to do that so. Please think we will discuss all these question in our upcoming lecture.

References:

1. https://en.wikipedia.org/wiki/Solar_system
2. https://www.noao.edu/staff/csalyk/AST101/presentations/Intrto_SS.pdf
3. http://www.jasonkendall.com
4. https://er.jsc.nasa.gov/seh/21_Solar_System_FC1.pdf
5. http://www.nineplanets.org
6. http://www.kidsastronomy.com

Reading Books

1. There are variety of best book available about the Sun. Some of nice books I found really good include: Make sure you can buy recent edition including information about current solar mission.
2. An excellent summary of everything there is to know about the Sun "The Cambridge Encyclopedia of the Sun" by Kenneth Lang.
3. "A journey to the centre of the Sun" 15 Million Degrees: by Lucie Green (Viking, 2016) is a fine read, starting from the basics.
4. A nice book, with lots of information about the people who made the discoveries "Journey from the Center of the Sun" by Jack Zirker (Princeton UP, 2002)
5. Another fascinating book written about the discovery of the solar cycle and space weather and It starts with the 1859 "superstorm" has lots of fascinating information about what we've learned about solar activity subtitled: "The unexpected tragedy of Richard Carrington and the tale of how modern astronomy began" (Princeton UP, 2007)
6. You can check out http://galileo.rice.edu/index.html; Galileo's Sunspot Drawings