

Understanding the Density of the Solar Wind



The average density of the solar wind is 3-5 particles per cubic centimeter. To get an idea of how incredibly low this density is, you will compare it to the density of the air around you.

Within a cm^3 of air at sea level there are approximately 2.5×10^{19} particles. That's 25,000,000,000,000,000 atoms and molecules. And when you add up their masses, it only amounts to 0.013 g. Hence, the density of air at sea level is 0.013 g/cm^3 . (By the way, a cubic centimeter (cm^3) is about the volume of the tip of your little finger.)

Imagine that we take a cm^3 of sea level air and place it in the “*Honey I Blew Up the Kids*” machine. We adjust the machine to magnify all the particles in the air to the size of a green pea. Let's calculate the volume of peas!

Step 1. Let's assume that the diameter of a green pea is 1 cm. Calculate the volume of a green pea. Remember, the equation for the volume of a sphere is $V = 4/3 \pi r^3$.

Step 2. Multiply your answer to step 1 by the number of particles in a cm^3 of air. Now you have calculated the volume of peas. (We'll ignore the space in between the peas.)

Step 3. Now we need to calculate the size of a reasonable container to fit them all. Let's consider the bottom of the container to be the continental United States. (Yes, we have that many peas!!) The area of the US is approximately $7,500,000 \text{ km}^2$. Convert this area to cm^2 .

Step 4. The equation for volume in this case is $V = A \times H$ (area times height). Calculate the height of the green peas.

As you can see, there are a lot of particles in a cm^3 of air. That's a lot of peas!! Now consider that in the same space we need to place the solar wind "peas". We get rid of all the air "peas" and place 3 peas at random spots across the US. This represents a scaled up view of the solar wind.



Questions

1. If you stand in your backyard while the wind is blowing 200 km/h, you will not be standing for long! However, if you were in space and exposed to the solar wind moving at 1 million km/h, not even the hair on your head would move. Explain this difference in effects from these two "winds".

2. Considering that the solar wind can't move the hair on your head but can deform the magnetosphere, what might you be able to conclude about the relative strength of the earth's magnetic field?