
LAST NAME

FIRST NAME

STUDENT NUMBER

Homework #1: Due in class Thursday February 2nd

What are sunspots? Why do they appear dark in pictures of the Sun?

Sunspots are dark patches on the Solar photosphere that mark regions where the magnetic field is strong. They are dark because the sunspot is cooler than the rest of the photosphere. Cool gases emit less thermal radiation than hot gases.

Images of the Sun taken in visible light and X-rays appear very different (see e.g. the picture in the Chapter of the textbook titled 'Our Star'). Why is this the case?

Visible light and X-rays are both electromagnetic radiation, but X-rays have much shorter wavelengths (higher photon energies). Only extremely hot gases (millions of degrees) emit significant X-ray radiation, whereas visible light is emitted by gas at 'only' thousands of degrees. Hence, the different types of radiation probe regions of different temperature, which are physically distinct. Visible light provides a view of the photosphere, while X-rays provide an image of the hot, tenuous gas in the corona.

If fusion in the center of the Sun were suddenly to cease today, how would the appearance of the Sun change tomorrow?

There would be no noticeable change, since photons take much longer than a day to leak out of the Sun. Eventually, the Sun would start to contract, but only very very slowly.

Why does nuclear fusion require high temperatures?

Atomic nuclei are positively charged, so they tend to repel each other. They have to collide violently to get close enough together for the strong nuclear force (which is very short range) to bind them together. High temperatures imply high velocities of the nuclei, increasing the very small fraction of collisions that result in successful fusion.

An astronaut on the surface of Mars learns that a coronal mass ejection on the Sun has occurred. If the material ejected travels at 1000 kilometers per second, how long will it take to reach Mars?

The Sun – Mars distance is 228 million km. To get the time, we need to divide the distance by the velocity:

$$t = \frac{228,000,000 \text{ km}}{1000 \text{ km/s}} = 228,000 \text{ s}$$

This is about 63 hours or 2.6 days.