

29:52 Exploration of the Solar System
Class Notes for April 11, 2008
The Jovian Magnetosphere

The Magnetospheres of Jupiter and Saturn

The fact that the interior of Jupiter is a liquid metal means that electrical currents can flow there. An electrically conducting liquid that is undergoing rotation and convection (an in-and-out boiling motion) acts like a *dynamo* that build up a strong magnetic field.

Both Jupiter and Saturn have strong magnetic fields, stronger than that of the Earth. Look at the comparison of the magnetic fields of Jupiter and Saturn to the Earth on p281 of the textbook. The basic statement of the strength of a magnetic field generated by a dynamo is something called the “magnetic moment”. The magnetic moment of Jupiter is 20,000 times that of the Earth.

The fact that the Earth (and even more so) Jupiter and Saturn have strong magnetic fields, in contrast to the other three terrestrial planets, means that they also possess *magnetospheres*, or regions of space which are dominated by the planetary magnetic field, and which hold off the flow of gas from the Sun called the *solar wind*.

Basic Physics and Magnetospheres

The reason the magnetic fields of planets like the Earth and Jupiter can deflect the solar wind is that a magnetic field exerts a force on a *moving* charged particle. The solar wind consists of atoms that have been ionized, or broken apart into electrons and ions, and so virtually all of the particles are electrically charged. We call an ionized gas like this a *plasma*. The solar wind is a plasma, and so is deflected by the magnetic field of a planet like the Earth. Look at Figure 8.28 for a diagram of the Earth’s magnetosphere. That of Jupiter is shown in Figure 12.22.

The “standoff distance”, or boundary between the magnetosphere and the solar wind, is about 100,000 km for the Earth, but about 2 solar diameters, or 3 million kilometers for Jupiter.

Information on the magnetosphere of Jupiter and its boundary with the solar wind (the “Jovian Bow Shock”) was provided by the University of Iowa radio experiments aboard the spacecraft Voyager 1 and 2, Galileo, and Cassini.

Internal Energy Sources of Jupiter and Saturn

Unlike what one would expect of a planet, Jupiter and Saturn emit more radiation to space than they receive from the Sun. In the case of Jupiter, the amount radiated

to space is about 70 % more than it receives from the Sun. This radiation is mainly in the infrared. Check out the description of this phenomenon in the textbook.

A final point is that some of the most interesting aspects of Jupiter and Saturn relate to their systems of moons. We will deal with that in a future lecture.