Planetary Wonderings
October Focus: IBEX
By Mary-Frances Bartels, NASA Solar System Ambassador

No, this article is not about goats, but rather the Interstellar Boundary EXplorer, a mission to launch sometime this month from an L-1011 airplane. Its task will be to study and map solar system boundaries and the heliosphere, the sun's atmosphere, consisting of plasma, or solar wind, and protects the solar system from harsh galactic material and radiation. IBEX will accomplish its mission from a high altitude orbit that will carry it almost as far from our planet as the moon.

Let us first examine the edge of our solar system. Defining the edge of the solar system is not as cut-and-dried as defining the edge of, say a table. Not only that, but this solar system boundary, however it is defined, changes over time, based largely on the sun's activity level. The solar system has three basic "boundaries:" Termination shock, heliopause, and lastly, bow shock. The termination shock is first, or innermost, solar system boundary which Voyagers 1 & 2 have already crossed. The TS is where the solar wind first starts to slow down, below the speed of sound, as it begins to interact with the interstellar medium. It compresses and heats up in the process. The heliopause separates the solar wind that comes from the Sun from the interstellar medium which comes from the galaxy. By the time the solar wind gets to the bow shock it is deflected back, similar to how water gets deflected back along the bow wave of a ship. Here is another way to think of the heliosphere: The sun and our solar system are like a ship moving through the interstellar medium. Out in front of that ship are a bow shock, which is very much like the bow wave in front of a boat, and interactions inside that are associated with the solar wind ramming its way through this interstellar material

Next let us examine the four states of matter --- solid, liquid, gas, and plasma --- paying particular attention to the last. A solid has atoms that are tightly bound together, and a fixed volume and shape. Heating up a solid will often cause it to change to a liquid, where the atoms are less tightly bound. Liquids have a fixed volume, but not a fixed shape. Adding heat energy to a liquid will often transform it to a gas. Gasses have neither a fixed volume nor a fixed shape, and their atoms are not bound, so they move around freely. When heat energy is added to a gas, these gas particles begin to move around faster. When enough heat energy is added to a gas, protons and electrons separate, forming a plasma, ionized gas.

Plasma has some interesting properties because the particles are ionized. When charged particles move, as they do in plasma, they create magnetic fields. These magnetic fields can then cause the moving plasma particles to travel in certain directions and strange paths. Plasma is the most common state of matter in the universe, comprising more than 99% of our visible universe and most of that not visible. While it makes up the stuff of our sun, it also occurs in quasars, x-ray beam emitting pulsars, and supernovas. On earth, plasma naturally occurs in flames, lightning, and auroras.

Why should we study the solar system boundaries? Scientists speculate that these boundaries protect the solar system, thus our planet, from 90% of cosmic rays. DNA-damaging cosmic rays affect all life on Earth and can increase the risk of cancer, cataracts, and neurological disorders.

Knowing how the solar wind protects the solar system from galactic cosmic rays is important for everyone from airplane to space travelers.

How can the interstellar boundary be studied? Scientists cannot use light because boundaries do not produce much light. So, IBEX will detect the very few neutral solar wind particles that return from the edge of the solar system after interacting with galactic material. By keeping track of these particles' energy and direction and time of detection, a map of boundaries can be made. Primary mission as two years, but scientists hope it will be extended so that the boundary changes can be studied as the sun's activity level increases.

Resource of the Month: www.nasaimages.org NASA and Internet Archive, a non-profit digital library, have created a comprehensive Internet compilation of NASA images. Officials said the NASA's vast collection of photographs, historic film and video combines, for the first time, 21 major NASA imagery collections into a single, searchable online resource. The Web site is the first step in a five-year partnership that will add millions of images and thousands of hours of video and audio content.

Activity of the Month: IBEX scientists are preparing a plethora of educational materials. Watch http://ibex.swri.edu/ to see when they become available to the public. To whet your appetite, tentatively planned activities include those that introduce the four states of matter, and also demonstrate how the addition of energy can transform matter from one state to another, use balloons to investigate how a multi-stage rocket, like that used in the IBEX mission, can propel a satellite to a specific orbit, and introduce the techniques IBEX will use to collect and count particles called Energetic Neutral Atoms (ENAs). Lithographs and posters will also be available.

Suggestions, questions, and comments about "Planetary Wonderings" are welcomed and may be directed to stargazer @ keeplookingup.net (remove spaces). Past columns may be found at www.keeplookingup.net (click on "Planetary Wonderings" on the right side of opening screen) and at http://www.freelists.org/archives/astronomyed/ (columns from Jan. 2007 to the present).

Remember to *keep looking up!*

Sources (not mentioned in the articled):
http://www.nasa.gov/mission_pages/ibex/IBEXDidYouKnow_prt.htm
IBEX training for Solar System Ambassadors
http://www.edinformatics.com/math_science/states_of_matter.htm