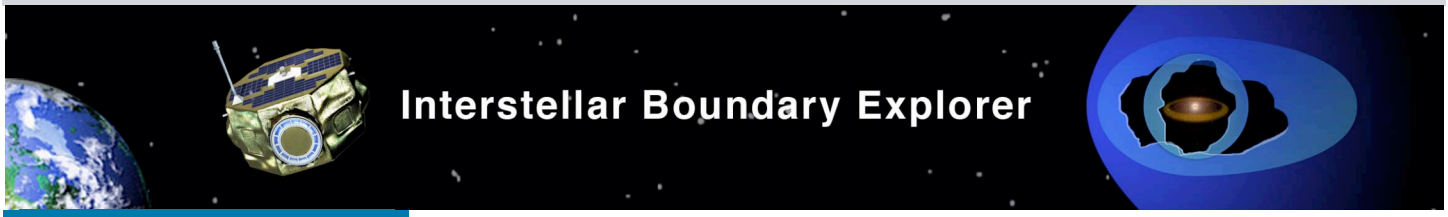
National Aeronautics and Space Administration



Public Outreach
- Activity

Particle Detection

About this Activity

This educator-led activity introduces museum visitors to the IBEX mission and the techniques it will use to collect and count particles called Energetic Neutral Atoms (ENAs). IBEX has two sensors, IBEX-Hi and IBEX-Lo. At any one time, each sensor only allows particles of certain energies to be counted. It also records information about those particles, including the direction that they came from. Then, each sensor switches to collect particles in a new "energy band." IBEX-Hi measures particles of higher energies in six energy bands, and IBEX-Lo measures lower energy particles in eight energy bands. There are a few energy bands that overlap for IBEX-Hi and IBEX-Lo. The IBEX spacecraft spins once every 15 seconds, and moves around the Sun along with the Earth once a year so that the sensors are exposed to each part of the heliosphere. As the IBEX Spacecraft orbits and spins, it cycles through the energy bands about every 3-4 minutes. In this activity, each IBEX sensor has 2 energy bands (buckets) for simplicity. The maps that IBEX makes will help to determine what the conditions at the boundary are like.

After completing the activity, participants will be able to:

- State that the boundary of the Solar System is invisible.
- Describe that IBEX detects the invisible boundary of our Solar System by collecting and sorting particles that come from the boundary

What You'll Need
(2 hours to make or get supplies)

- 4 medium-sized buckets/boxes painted or covered with colored paper and numbered as indicated in the Set-up Diagram (Bucket 1- half red/half orange, Bucket 2- half orange/half yellow, Bucket 3- half yellow/half green, Bucket 4- half green/half blue)
- 2 pieces of stiff cardboard or lids to cover the buckets when not in use
- 50-100 small beanbags (red, orange, yellow, green and blue), a cheaper alternative may be balloons filled with sand or rice.
- Masking tape
- IBEX spacecraft poster or picture
- 16 clear tubes or cylinders (e.g. graduated cylinders) that are big enough in width to accommodate the beanbags numbered as in the diagram
- An area at least 10'x10'

To Do

Recruit 4-30 participants to play Particle Detection. Tell them they will launch particles from space to demonstrate how the IBEX spacecraft works.

1. Introduce the IBEX mission. Using the IBEX poster or picture, explain that IBEX is a spacecraft orbiting the Earth. It will collect data about particles that will allow scientists to make the first map of the boundary of the Solar System. Explain that we have to collect particles from the boundary because it is invisible and we cannot take a picture, as with other objects in space.
2. Ask participants to stand in a large circle around the buckets on the floor modeling the boundary of the Solar System. Tell them that the boundary is REALLY far away, at least twice as far as Pluto's orbit. We know the distance to two points on the boundary from observations from the Voyager Spacecraft. Explain that the boundary of the Solar System is made by the Sun. It is formed when the solar wind (which is charged particles from the Sun) meets and interacts with the Interstellar Medium, ISM (which is the material that fills the space between the stars). When the solar wind and ISM collide at the boundary, they make energetic neutral atoms, ENAs. Some of the ENAs travel from the boundary, through the Solar System and towards the IBEX spacecraft where they can be measured.
3. Using the IBEX poster or picture, point out that IBEX has two particle collectors called IBEX-Hi and IBEX-Lo. Point to the STOP sign outline on the floor. That represents the spacecraft. One side is IBEX-Hi, and one side is where IBEX-Lo is located. Explain that each sensor collects particles from the boundary of the Solar System.
4. Explain that the spacecraft has special switches that allow the sensors to collect particles of different energies. For example, IBEX-Hi sometimes detects particles with high energies (represented by the blue and green beanbags) and sometimes detects particles of medium energy (represented by the yellow beanbags.) IBEX-Lo sometimes collects particles of medium energy (yellow beanbags) and sometimes collects lower energies (orange and red beanbags.) Point out the two buckets that represent IBEX-Hi and the two buckets that represent IBEX-Lo.
5. Explain that the IBEX spacecraft spins to allow it to collect particles from each part of the

Preparation (10 min)

- Tape an eight-sided (STOP sign) shape onto the floor
- Tape lines on the floor to mark quadrants as shown in diagram
- Place colored buckets into the taped shape on the floor as in the diagram
- Arrange four cylinders outside of each quadrant to hold the collected "particles"

Assessment

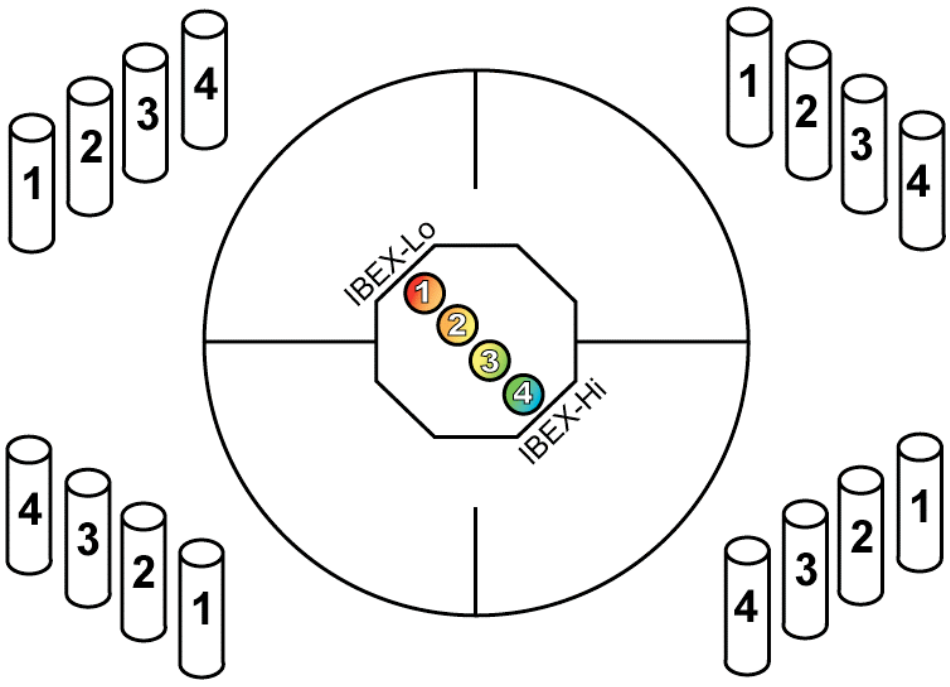
Finish the demonstration by asking participants:

- Can we see the boundary of the Solar System? (No.)
- How can IBEX measure the boundary? (By collecting and sorting particles that come from the boundary.)

boundary. IBEX counts and measures the particles and records the time and area of the boundary that they came from, but it is not able to determine the distance they traveled. Scientists can then see how many particles of each type come from each area of the boundary and make a color coded map to display the data. This information will help us understand what the boundary of the Solar System is like.

6. Pass out beanbags to the participants. Give four or more to each participant, depending upon the total number of participants and beanbags. Make sure the colors are spread out randomly around the circle. Explain that these beanbags represent the invisible particles called ENAs. The color represents how much energy each particle has (blue has the most energy and red has the least.)
7. Place a lid on two buckets, one for each sensor so that it cannot gather particles (this is the "switch").
8. Ask participants in two opposing quadrants to toss one of their particles selected at random towards the IBEX spacecraft. Try to have the participants toss their particles only towards the sensor closest to them and not the one further away. Explain that really the ENAs travel in random directions so we are only representing the ones that happen to leave the boundary region and travel back towards the IBEX spacecraft.
9. Now "switch" the sensors so that the other bucket is "open" and the first is closed.
10. Ask a participant to help you transfer particles that landed in the "correct" buckets to the clear cylinders for that quadrant. For example, only move blue and green beanbags that were in the IBEX-Hi bucket that is blue and green. Move them to the cylinder marked "4" in the diagram. Set aside any "particles" that landed in the incorrect bucket to be used in another round.
11. Now rotate the IBEX spacecraft so that the sensors are exposed to the other two quadrants.
12. Repeat the tossing, sorting and transferring of the particles into the cylinders for several rotations. Make sure to point out how the IBEX sensors collect and "sort" the particles.
13. Ask the participants to observe the height of the particles in the cylinders for each quadrant.
14. Explain that IBEX will use its antennae (point out on the image) to send the data to scientists on Earth so they can make a map for each energy range that explains the number of particles of that energy for each area of the sky.
15. Ask the participants questions from the assessment section to confirm that you have met the activity objective. Thank the participants for their help.

Diagram – Set-Up



Related Websites

NASA's IBEX mission page explains the science behind the mission.
http://www.ibex.swri.edu

NASA's Science Directorate summarizes information about the Heliosphere.
http://nasascience.nasa.gov/heliophysics/heliosphere