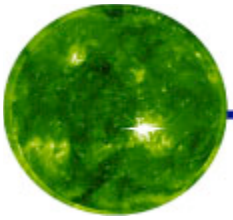

# Interplanetary Pool Games

## Elementary Grades

**Lesson Summary**
There are three consecutive activities. Students observe the effect of light on light-sensitive paper and model how scientists collect data about the composition of plasma.

**Prior Knowledge & Skills**
Understanding of:
- Scientific process and inquiry
- Models as a means of representation
- Random events

Ability to:
- Collect and interpret data
- Model natural phenomena

**AAAS Science Benchmarks**
**The Nature of Science★**
*Scientific Inquiry*
**The Nature of Mathematics**
*Patterns and Relationships★*
*Mathematical Inquiry*
**The Nature of Technology★**
*Technology and Science*
**The Physical Setting★**
*The Structure of Matter*
*Energy Transformations*

**NSES Science Standards**
**Science as Inquiry**
*Abilities to do Scientific Inquiry★*
*Understandings of Scientific Inquiry*
**Physical Science★**
*Properties of Objects and Materials*
*Position and Motion of Objects*
**Earth and Space Science**
*Objects in the Sky★*
*Changes in the Earth and Sky*

**NCTM Mathematics Standards**
**See Appendix**

**Teaching Time**: Two to three 45-minute periods

**Materials for Teams**
- Sun sensitive paper
- Clipboards or solid writing surface
- Index cards size
- Access to water
- Many balls of various colors
- ❖ *Student directions and data collection page(s)*

*Editor's Recommendation*

**Advanced Planning**
**Preparation Time**: 20-30 minutes
1. Review activities
2. Practice using the Sun sensitive paper
3. Produce student directions and data recording sheets

***Editor's Note***
*This set of activities would benefit from the addition of student pages with procedures and data recording sheets.*

*Northern Lights and Solar Sprites*, pp. 56-59, NASA, EG-2000-XX-XXX-GSFC
http://image.gsfc.nasa.gov/poetry/dimarco.html

LASP
LABORATORY FOR ATMOSPHERIC AND SPACE PHYSICS

# XI...Interplanetary Pool Games

## Introduction:

**What does the Neutral Atom Imager on the IMAGE satellite do?** The Neutral Atom Imager on the IMAGE satellite uses remote sensing to find out more information about the clouds of charged particles (plasma) that surround the Earth. When some of the particles in the plasma are collected by the Neutral Atom Imager, they are measured. Scientists can determine the composition of these particles, their energy, and from what direction they came. Once all this information has been collected, the scientists can make pictures of where in space the particles came from. The students will make a simple "collector" of information, in this case, film similar to that used in a camera. Then the students will explore a model of how the Neutral Atom Imager collects and measures (counts) these particles.

## Objectives:

- The students will explore how a scientist uses an instrument as a collector of information.
- The students will explore how a scientist measures (counts) and records the information collected.
- The students will explore a model to see how the Neutral Atom Imager collects and measures particles in the plasma surrounding the Earth.

## Materials:

Sun sensitive paper - Two possible brands available are listed below (there are others)

Nature Print Paper - available at hobby and craft stores

_____

Sunprint Paper - available at hobby and craft stores

_____

Cardboard or clipboards for groups

Index cards (size is dependant of the size of your print paper)

Tape

Access to water (sink or tray full)

Balls

**Grades K-6 -**

- You need four different colors of the same types of balls - for example if you were using foam balls, you would need five blue, two red, four green and six purple. The number of each color of balls can be different - it's the different colors that are important.

**Grades 5-6- (Extension activity)**

- You need four different colored balls, but three different types of balls for each color -for example, blue foam balls, blue tennis balls, and blue lacrosse balls.

## Procedure:

- Scientists use remote sensing to collect information about things that are not always visible. Take for example, the sun. Scientists and teachers know that we can not see the sun's light energy on Earth. We can see the results of the sun's light energy in a sunburn we receive, or when we touch a hot car that has been sitting in the sun. The students will use paper that is similar to film in a camera to collect the sun's light energy. Place one sheet of Natureprint or Sunprint paper outside the classroom with a leaf on it. The paper will absorb or "collect" the sun's light energy by changing the color of the paper except in the area where the leaf sat, when developed in water. Scientists use instruments with more sensitive collection mechanisms on satellites.

- The students will now use the Natureprint or Sunprint paper to make an exposure frame that will measure how much of the sun's light energy was absorbed. Each student group will need a piece of cardboard or a clipboard, an index card slightly larger than the print paper, a piece of print paper and of course, sun! The students should tape just the corners of the print paper onto the cardboard or clipboard. Then the students should cut the index card almost all the way across four times. The result should be a hinged flap sheet. Label the flaps with 1, 2, 3 and 4 minutes, which will represent the exposure time for each portion of the print paper. The flap sheet should be placed on top of the print paper prior to going outside. Have the students place the print paper and flap sheet in a sunny area closeby to the timer. The students should lift flap one for a timed one minute interval, then place the flap back over it. Next, flap two should be lifted for a two minute interval, and covered after its exposure. Continue this way for flaps three and four. Take the exposure frame inside, but do not develop it with water. The students should be able to see varying shades of color on the print paper. If you go back and look at your print paper later, you will notice that there will no longer be varying shades of color because the print paper will continue to absorb light energy, even inside. The NAI uses a more complex method of measuring energy.

- How does the Neutral Atom Imager (NAI) collect and measure (count) the particles in the plasma? Let's use the game of baseball as an example; the catcher can model the collector, the field can model the plasma surrounding the Earth, and the balls thrown into the catcher can model the charged particles that the NAI collects, which are mainly hydrogen, nitrogen and oxygen. The field is going to be divided into four quadrants which are familiar to those who play the game. These will be left outfield, right outfield, left infield and right infield with the infield ending on the dirt area on the outside of the bases. Each of the quadrants will have a specific color ball assigned to it that will be thrown to the "collector", for example all balls from the left outfield would be blue. Send one student into each of the four quadrants with the assigned bucket of balls and one to be the catcher (with a mitt of course!) The NAI is now ready for operation. Have the students begin to throw their balls into the catcher, who will place all the balls into one big bucket. When all the balls have been thrown, the students will be constructing a scattergram by counting and plotting the balls by color on the attached graph. A scattergram is a graphic that displays how many times something occurred within a specific area. You may have seen these during broadcasts of football and baseball. In football, they are used to show where the quarterback has thrown to his receivers. In baseball they are used to show where a player has hit the ball or where the pitcher has placed each pitch in relation to homeplate. The NAI collects the particles and records the direction they were received from.

# Extensions:

**Grades 5-6**

- With a slight variation in the baseball model above, older students can gain an understanding of how the NAI also collects and measures particles based on composition. Each of the quadrants will need to have specific ball colors, but now will need to have different types of balls that match the color. For example, if the left outfield balls are blue, this time you would need to have blue lacrosse, tennis, and baseballs. Each type of ball represents the different elements that are most commonly found in the plasma; nitrogen, oxygen and hydrogen. It is important to note, that each quadrant would have a trend or pattern as to the makeup of its particles. For example, the right outfield would have mostly hydrogen with some nitrogen and oxygen. The assignment of types of balls per quadrant should not be random.

# Conclusions:

The students will gain an understanding of how scientists use instruments to collect, and measure information. The students will understand that scientists have adapted instruments to collect information about items in space that we can not always see through the use of remote sensing. The Neutral Atom Imager is an example of an instrument that collects and measures particles that are not visible to us on earth.

## Scattergram # 1

Directions: The students should make a dot in each quadrant for each of the balls that was thrown into the catcher from that direction.

| Left outfield | Right outfield |
|---|---|
| Left infield | Right infield |

## Scattergram #2

Directions: The students will make a dot in each quadrant for each of the balls that was thrown into the catcher from that direction. There will be three scattergrams completed, one for each of the compostions represented by the different types of balls.

| Left outfield | Right outfield |
|---|---|
| Left infield | Right infield |

| Left outfield | Right outfield |
|---|---|
| Left infield | Right infield |

| Left outfield | Right outfield |
|---|---|
| Left infield | Right infield |