Scintillating stars

During the next two months, Jupiter and Saturn, the two largest planets in our solar system will be visible at night as they slowly wander eastward across the constellation boundaries of Cancer and Taurus. At the same time, and closer to home, the planets Venus and Mars will also be wandering across the boundaries of their respective constellation hosts, Sagittarius and Ophiuchus.

Often, a bright planet that is visible over the horizon will be mistaken for a star. Some believe that they can tell the difference between a star and a planet because stars twinkle, or *scintillate*, and planets do not. In actuality however, both will twinkle because any light that passes through our atmosphere, whether it be reflected from a planet or generated by a star, will be interfered with by the atmospheric elements. A better, albeit more time-consuming, method of telling the difference between a star and a planet would be to observe the object in question for a period of several days, perhaps even a few weeks. If, after a period of several days, the object's position has changed with respect to the stars around it, then it is more than likely a planet.

In effect, this is why certain objects in the sky were named "planets." Early observers of the night sky noticed that over a period of time a number of "stars" moved while the rest of the starry sky didn't. This was not an apparent motion due to rotation or revolution, but rather a real motion, that of planets moving around the Sun in their orbital paths. *Planet*, from the Greek, means "wanderer." However it originally was a reference to only the five visible planets (Mercury, Venus, Mars, Jupiter, and Saturn). Since those days, and thanks to the invention of the telescope, we have added three additional planets to our solar system (Uranus, Neptune, and Pluto), numerous large icy objects (1992 QB1 and Quaoar for example) in the outer solar system, and approximately 100 extra-solar planets (planets orbiting stars other than ours).

So what started out as a fairly uncomplicated classification system—planets wander and stars do not—has become more complicated due to recent discoveries within our solar system. Now, thanks to technological advances in observing and detection techniques, we have come to a point where it may be time to adjust the definition of "planet."

Is Pluto a planet?

This question provides an opportunity for students to conduct some research and discuss what determines whether an object is a planet or not. Before getting into a discussion about the pros and cons of changing a planet to non-planet status, have your students research the properties, features, and characteristics of the various members of our solar system (see Figure 1 and Internet resources). Have them brainstorm about the defining features of the objects, such as, "Is a planet simply an object orbiting a star? If so, what determines planet or non-planet status for the myriad of objects that orbit our star?" As a result of their research, students will realize that there are many parameters that define a planet.

Within our incredibly vast solar system there are several groups of objects (planets, moons, rings, asteroids, and me-

FIGURE 1 **The surface of Pluto**

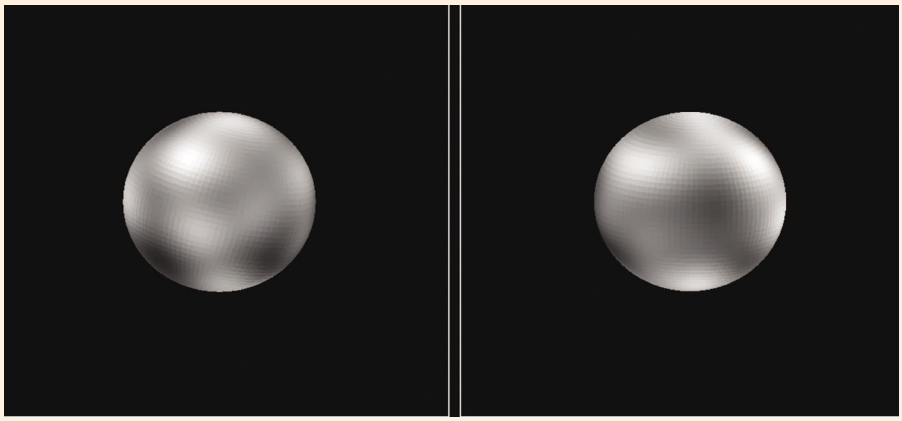

PHOTO COURTESY OF ALAN STERN (SOUTHWEST RESEARCH INSTITUTE), MARC BUIE (LOWELL OBSERVATORY), NASA, AND ESA

The surface of Pluto is resolved in these NASA Hubble Space Telescope pictures, taken with the European Space Agency's (ESA) Faint Object Camera (FOC) aboard Hubble. The images are from a global map constructed through computer image processing. The pictures were taken in blue light when Pluto was at a distance of 3 billion miles from Earth.

FIGURE 2 **Sample research questions**

Object	Research question
Sun	What is it that makes our Sun, or any other star for that matter, different from a planet?
Terrestrial planets	What features of the Earth do other objects need to be considered a terrestrial planet?
Asteroid belt	What is an asteroid? Why is it not called a meteoroid? Can they have moons?
Gas and ice giant planets	How are these planets different and similar to each other? Why is Jupiter not a star?
Kuiper Belt	What is the Kuiper Belt? Where is located? What is found within this region?
Oort Cloud	What is the Oort Cloud? Where is located? What is found within this region?

teoroids, as well as icy bodies such as comets) in various orbits around the Sun. Planets have traditionally been grouped into two categories, the terrestrial (Earth-like, or inner planets) planets—Mercury, Venus, Earth, and Mars; and the outer, or Jovian, planets—Jupiter, Saturn, Uranus, Neptune, and Pluto. The diversity even within these two groups is apparent, and Pluto does not fit in very well in either of the categories. Pluto displays properties of both the terrestrial and Jovian planet groups, as well as properties of a group of icy objects called Trans-Neptunian Objects (or simply TNO's) that occupy the Kuiper Belt, a region of the solar system beyond Neptune.

To begin, students should assemble whatever facts they can about our solar system—its structure (regions where specific objects are located), motions of the objects, as well as physical properties and features of the various members. By arranging data in a manner that allows for easy comparison, students may then organize the solar system into groups based on similar features and properties. Students should then be prepared to decide the planetary status of Pluto. Our solar system can be arranged by regions to show differences and similarities, and students can then start to formulate their own research-guiding questions. (See Figure 2 for some examples). ■

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Internet resources

U.S. Naval Observatory, Earth's seasons—*aa.usno.navy.mil/data/docs/EarthSeasons.html*
1992 QB1—*www.ifa.hawaii.edu/faculty/jewitt/kb/qb1.html*
Quaoar—*www.gps.caltech.edu/~chad/quaoar/precovery.html*
Kuiper Belt—*www.ifa.hawaii.edu/faculty/jewitt/kb.html*
The nine planets—*seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html*
SFA Observatory—*www.physics.sfasu.edu/astro/SFAStarCharts.html*
Solar system simulator—*space.jpl.nasa.gov*
Solar System Educators Program—*www.ssep.org*
Extra-solar Planets Catalog—*www.obspm.fr/encycl/catalog.html*

Celestial events

2/02 Jupiter at opposition

Visible planets

- Venus is visible over the southeastern horizon at sunrise.
- Earth is visible under your feet.
- Mars is over the southeastern horizon at sunset.
- Jupiter rises at about sunset and is visible all night.
- Saturn rises before sunset and is visible all night.

Moon phases

February	
New Moon	2/01
First quarter	2/09
Full Moon	2/16
Third quarter	2/23