Familiar and Unfamiliar

When asked to draw or model the Universe, most students choose to illustrate the Solar System, either because this is the part of the Universe with which they are most comfortable, or because their model of the Universe consists only of Solar System objects.

Systems in Space

Often, students believe that Pluto is the most distant object in the universe and that all other objects are located within its orbit. These “other objects” consist of stars, galaxies, and other items that may or may not have concrete meaning for students.

Models and Misconceptions

A misconception is more than a “wrong idea.” Student ideas reflect deeper understandings, which must be integrated into more sophisticated models, or refuted through new evidence that causes them to re-evaluate their model. How can you help your students create an integrated model of the Solar System within the larger context of our Galaxy and the Universe?

...and the evidence actually tells us:

- Nine planets of very different size, composition, and surface features move around the Sun in nearly circular orbits.
- The Sun is many thousands of times closer to the Earth than any other star.
- The Sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars.
- Other planetary systems exist around other stars, also within our Galaxy.

Solar System

**Questions:**
- Where are we in the Universe?
- What is a Solar System?

**Commonly held, but incorrect ideas...**
- The Universe is the size of the Solar System.
- Planets move along tracks in the sky.
- The Big Bang created the Solar System.
- Models are exact copies of reality, and illustrations seen in textbooks accurately represent all features of the real thing, unless otherwise noted.
- Planets are the most prevalent objects in the Universe.

Galaxies

**Questions:**
- What is the Universe made of?
- What is a Galaxy?
- Where are the objects in the Universe?

**Commonly held, but incorrect ideas...**
- Our Galaxy consists of planets orbiting a very large star.
- The Milky Way is a band of “space stuff” in the sky, similar to the asteroid belt.
- Objects are scattered randomly throughout space with no overall organization.
- Black holes are either tunnels or giant vacuum cleaners in space.

**...and the evidence actually tells us:**
- Our observable Universe contains billions of galaxies, each of which is a gravitationally bound cluster of stars (some of which have planets), gas, and dust. Galaxies now form most of the visible mass of the Universe.
- Some distant galaxies are so far away that their light takes several billion years to reach the Earth. People on Earth, therefore, see them as they were that long ago in the past, when the light left them.
- It is impossible to know how the Universe and the objects in it have changed over time.
- Our Galaxy consists of planets orbiting a very large star.
Spacecraft and telescopes travel between stars and galaxies in the Universe.

Stars and galaxies have always existed.

Everything we observe today was created in the Big Bang.

There is a physical edge to the Universe.

Galaxies are moving away from the center of the Universe.

Questions:
- What is the Universe like?
- How big is the Universe?
- How old is the Universe?
- Is there an edge to the Universe?

Commonly held, but incorrect ideas...
- The Big Bang is “just a theory” and has no evidence to support it.
- There is a specific spot in the sky where the Big Bang happened.

Substantial evidence supports the Big Bang model of a hot, dense, chaotic mass that began expanding explosively over 10 billion years ago, eventually forming today’s Universe.

Stars condensed by gravity out of clouds of the lightest elements. Nuclear fusion in the cores of stars created heavier elements. Some stars exploded, scattering heavy elements from which other stars and planets could later condense. The process of star formation and destruction continues.

The Universe and its contents changed considerably over time and continue to change today.

Our view of the Universe is limited by the time it takes light to reach our eyes, not by a physical boundary to space.