Modeling the Universe: *Create Your Own Cosmos*

Goals:

- To have fun!
- To represent earth's physical place in the solar system and universe
- To understand astronomical size and scale
- To understand strengths and weaknesses of models

Materials:

- modeling clay
- paper
- balloons
- different sized balls and marbles
- string
- markers
- scissors
- straws
- other odds and ends that might be useful in creating models
- Copies of Universe Model Analysis Worksheet for each group

Background:

Our Milky Way is just one of countless galaxies in the universe. Our view of the universe is expanding. Less than a century ago, astronomers thought that our Milky Way galaxy of stars might be the whole universe. Today, we can observe the splendor of galaxies far beyond our own. We can see the estimated 100 billion galaxies that make up our "observable universe".

In the 1980s, Margaret Geller and John Huchra began a survey of the distances to 25,000 galaxies. To their surprise they found that galaxies are grouped in vast filaments and sheets. There appear to be great voids where no galaxies are found. Today teams of astronomers all over the world are mapping thousands of galaxies, in search of clues about the size and shape of the cosmic web.

In this activity students are challenged to create a model of the universe in a single meeting.

Getting a "big picture" of the universe as a whole is a difficult challenge — for professional astronomers as well as for students — but it's a challenge that has occupied humanity for ages. To understand the vast ranges of scale of cosmic systems, the student of the universe has to create and evaluate a variety of models against the observational evidence.

A model is a simplified imitation of something that we hope can help us explain and understand it better. Models can take different forms, including physical devices or sculptures, drawings or plans, conceptual analogies, mathematical equations, and computer simulations. In this activity,

students make a physical model to represent as much of the universe as they can. They will then analyze their own and others' models with regard to what they represent, what they misrepresent, what they leave out, and perhaps most importantly, what questions they raise.

While the idea of creating a physical model of the entire universe in one sitting can seem a bit daunting, this activity quickly elicits student ideas and preconceptions about the contents and organization of the cosmos. Most students will be somewhat familiar with solar system objects, but may be confused about the relationship of stars to planets, and about the relative distances. The scientist's view of the hierarchical "nested" structure of the universe—planet systems, star neighborhoods, galaxies, galaxy clusters—is not second nature to most people.

Suggestions for Introducing the Activity:

This is an introductory activity that helps students think about where we fit in the universe, and model the size, shape and relative position of objects in the universe. Students should be familiar with the objects in our solar system and terms for celestial objects beyond our solar system. This activity begins with students brainstorming about objects in the universe and the concepts of models. Students with less experience with these concepts will require more time and teaching in the discussion part of the activity.

Procedure:

Part 1. Discussion

- Facilitate a class discussion of what's in the universe. Ask students ”What IS the universe?” Brainstorm a list of objects in the universe that can be viewed with a telescope. As students mention different objects, ask them what they know about them. What is a planet? What is a star? What is a galaxy? How far away are these things, relatively speaking? What do you think they would look like in the telescope? Which ones can we see without the aid of a telescope? How could we group the objects?
- Discuss how scientists use models to suggest how things work and to predict phenomena that might be observed. Ask students to name some familiar models, such as a globe, or a dollhouse. A model is not the real thing. It can always misrepresent certain features of the real thing. Different models may represent only part of what is being modeled.

Part 2. Modeling

- Divide into groups of 3-4 students. Each student can have one or more of the following roles: model maker(s); recorder of model features; spokesperson.
- Challenge students to create a model of the universe in less than 30 minutes. You may wish to have some groups choose just a part of the universe to model (such as the solar system, or a galaxy, or perhaps just the earth-moon system). One person in the group should write down the features of the model as it is built, along with questions that arise.
- Students can use the Universe Model Analysis Worksheet to record the features of their model as they work.

Part 3. Sharing Models with the Class

- As each group presents their model ask them to comment on these 4 questions:
  - What features of the universe does your model represent?
  - What things does your model misrepresent?
  - What things about the universe does your model omit, or not represent at all.
  - What questions came up as your group worked on your model?

Discussion Notes:

After sharing all the models, discuss the following questions. Are there any patterns that emerge?

What parts of the astronomical models do you think represented the "real thing" particularly well? Why?

What parts of the astronomical models do you think misrepresented the "real thing"? Why?

Why is representing the whole universe a difficult challenge?

What are some things you need to find out to design a better model?

Universe Model Analysis Worksheet

A model is a simplified imitation of something to help us understand it better. Because a model is not the real thing, it can always misrepresent certain features of the real thing. Different models may represent only part of what is being modeled.

After your group creates your model, you will be asked to explain your model to the rest of the class, commenting on these 4 questions:

What features of the universe does your model represent?
What things does your model misrepresent?
What things about the universe does your model omit, or not represent at all.
What questions came up as your group worked on your model?

Use this chart to record the features of your model as your group is working.

Features Represented	**Misrepresented or irrelevant features**	**Features of real thing omitted by model**
Questions we had:		