

1.7: Scale the Universe

Learning Objectives

- You will create a scale model of the Solar System and relate it to everyday and galactic scales

What Do You Think: Scale Model Solar System

One day while eating lunch, Adam, Carlos, and Jemisha are discussing the scale of the Solar System.

Adam: “If this cantaloupe was the Sun, then I think Earth would be the about as big as a cherry.”

Carlos: “No. I think Earth would be smaller than that. It would be about as big as this raisin.”

Jemisha: “I think raisins and cherries are still too big. I think Earth would be the size of this little black poppy seed on my bagel.”

You might not be aware that all the planets of the Solar System revolve around Stockholm, Sweden. Or more precisely, that they revolve around the Ericsson Globe, an indoor hockey arena in the city. In a leap of imagination, the Swedes have used the Globe—which is a semi-spherical building resembling an over-sized golf ball with a 110-m diameter—as the basis for a scale-model solar system. The Globe plays the role of the Sun, and all of the other planets, along with their distances from the Sun, are scaled accordingly. This gives a model solar system 20 million times smaller than the actual one, as shown in Animated Figure 1.30.

To find Earth, you must travel about 7.5 km from the arena and look for a sculpted sphere 64 cm in diameter. Jupiter is nearly 40 km away and is more than 7 m across. To find the last known planet in the solar system, Neptune, you must travel more than 200 km and find a ball 2.5 m across. A few trans-Neptunian objects, like Pluto, Eris, Sedna, and others, are also included in the map. If you travel to the far north of the country, almost to the Finnish border, you will find a representation of the terminal shock of the solar wind. That is where charged particles from the Sun slow down as they run into gases from the interstellar medium. Clearly, it helps to have a car or a train schedule and a good set of directions to visit all the objects in this model solar system.

If you would rather view the Solar System on a more manageable scale, you could travel to the National Air and Space Museum in Washington, D.C. The museum has built a model, called [Voyage Through the Solar System](#), pictured in Figure 1.31, using a much smaller scale: each of the objects is 10 billion times smaller than its real counterpart. On this scale, the Sun is about 16 cm across, Earth is 15 m away, and even the farthest planet, Neptune, is only 450 meters distant. The smaller scale makes the Voyage scale model much easier to take in at a glance. The price paid, of course, is that some of the objects are very small. Jupiter is a small sphere, about the size of a marble. Earth is tiny, barely more than one millimeter in diameter. And, of course, objects like the Moon, Pluto, and other subplanetary bodies are barely visible at all.



Figure 1.31: A view of the inner part of the Voyage Through the Solar System scale model in front of the National Air and Space Museum in Washington, D.C. Credit: Smithsonian Institution, Eric Long.

So, what is the best scale to use for a model solar system? The next activity will let you decide for yourself. You will be asked to choose a scale and then to build a solar system model using commonly available objects for the Sun and planets. If you choose too small a scale, you will have a difficult time finding objects to represent Mercury, Earth, Mars, etc. If you choose too large a scale, you will have a difficult time placing all the objects at their proper distance from the Sun. There is no getting around it. The

distances between the planets are so vast compared to their sizes that finding a good scale to represent everything is a difficult task. And what about the stars? We will ask you to consider that when you have finished your model.

Scale Model

To get started, choose a scale. You should probably choose something smaller than 1:20 million unless you want your model to stretch all the way across Sweden! Use the tables of data for the Solar System, and scale all the values down by your chosen scale. For instance, if you use a 1:10 billion scale, then you would divide the size of the Sun by 10 billion, and your model Sun would be about 0.14 meters across. All other sizes and distances would be similarly diminished. You can use a calculator or spreadsheet to do this task. Or if you prefer, there is a nice online tool to help you at: [Build a Solar System](#).

If you are extremely squeezed for space, then it will be impossible for you to build a model that allows you to both see the planets and their separations from each other at the same time. Some teachers, when faced with this problem, have come up with a convenient solution that at least allows their students to get an idea of the distances separating the planets: they use a scale model where one sheet of toilet paper is 1 AU. This scale is easy to fit into a classroom, but it has the drawback that the planets are all too small to see. Even the Sun is a mere dot on this scale.

When you have chosen a scale for your model, think of some objects around your house that you can use to represent the planets. For instance, on the Voyage Through the Solar System model in Washington, D.C. (it uses a scale of 1:10 billion), Jupiter is about the size of a small marble, whereas Earth is about the size of a poppy seed. The entire model is about half a kilometer in radius, so you can see that you will have to use very small objects to represent the planets if you want your model to be a reasonable size.

As we have mentioned, a scale model such as the one described here has been built on the south side of the Capitol Mall in Washington, D.C. It is located in front of the National Air and Space Museum. Other models to the same scale can be found in several cities around the United States. In addition to these Voyage models, there are many Solar System scale models around the country (and the world) that use different scales. We have compiled a listing of these models for you. If one of them is nearby, it might make a good destination for an outing.

SCALE MODEL SOLAR SYSTEMS IN THE UNITED STATES

- [McCarthy Observatory](#), New Milford, CT (links to home page; click on Solar Sys link at top of page to view info)
- [University of Colorado Boulder](#)

SCALE MODEL SOLAR SYSTEMS AROUND THE WORLD

- [The Australian Solar System](#) (page has driving instructions with distance and times given)
- [The Swedish Solar System](#) (page has information and map)

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