SOLAR SYSTEM SCALES

Educational Experiences for K-12 in the Earth and Planetary Sciences - Module 7

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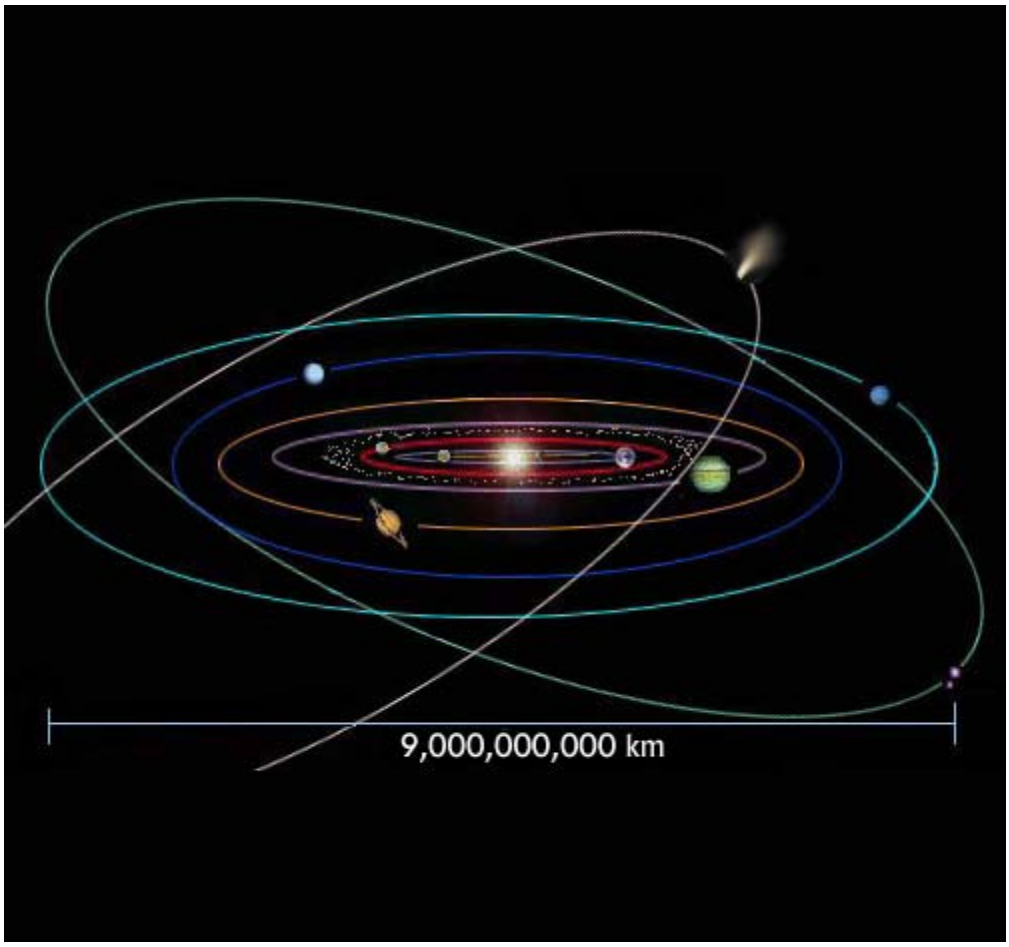

SOLAR SYSTEM SCALES - MODULE 7

1. Introduction

The objective of the *Solar System Scales Event* this event is to introduce or further explain scales, scale in the solar system, and the challenges presented by the scales of distance in our Universe. The event consists of three parts; a short presentation, an outdoor hands-on exercise, and a closing question answer session with handouts. Educators or presenters may use these resources how they wish (within the CC license terms), however, the order and approach presented here has been tested and used previously with success.

2. Learning Objectives

- Introducing or further explain scales, how they are used, and what they can tell us.
- Gain an understanding of the challenges of space travel due to scale.
- Encourage participants to consider STEM fields like Space or Planetary Science as possible career choices.

3. Materials

3.1. Presentation

Material are included for the presentation. More materials can be found on the internet at places like those on the included resource sheet.

3.2. For the field exercise

- printouts of planets at scaled sizes are useful. Some are already attached. If they are the wrong scale, you can use the calculator at http://www.exploratorium.edu/ronh/solar_system/ to get measurements to scale other images.
- A tape measure that can be used to measure out the distances. A field tape or wheel measure is suggested. At the 1" solar scale, the distances between planets can be up to 100 feet.
- Strongly suggest at least two presenters - three preferred. One each at the Sun, Neptune and walking back and forth (the speaker).

3.3. Packet

There are handouts in this module including the scales page and additional resources page that can be part of a packet. Other suggestions include small inexpensive "Experience Reminders" (souvenirs) and stickers.

4. Activities

4.1. The Presentation

Mission data obtained from the NASA PDS, Planetary Photojournal, and visualizations from the Eyes on the Solar System product are used in a short presentation before a group activity. In the following pages are also

"slides" that can used by the presenter as needed, but ***PLEASE*** keep credits intact. They are currently in order for a short presentation or as handouts. For availability of the original .ppt slides, contact C. T. Adcock (see title page of presentation).

4.2. The Hands-on Activity

The activity in this event is an outdoor exercise using a scaled Sun and planets (printed on pages that follow with white backgrounds). It lasts ~30 minutes, but is variable depending on the presenter. Student participant volunteers play the roles of the Sun, planets, major moons, and potentially minor moons and asteroids if there are many participants. Starting at the Sun, a participant is given the sheet that corresponds to the Sun and then stays in that spot. Then the scaled distance is measured outward to the next planet or object and a participant is given the sheet that corresponds to that object. The participant stays in that spot, and so on for the rest of the solar system objects. Remaining participants are assigned to moons and asteroids (in the asteroid belt).

A sheet is provided in this module with scale distances to be used with the planet sheets. See also http://www.exploratorium.edu/ronh/solar_system/ for other/custom scales. With the Sun being a 2.5 cm (1 inch) sphere, the distance to Neptune would be roughly 90 meters (~ a football field). At this scale, Mercury would be represented by the diameter of a section of fishing line. This scale has shown to be ideal - just big enough, but not too big - for some school playgrounds. There is also a 1.25 cm Sun option on the sheet (45 meter solar system) which is about half the size. By the time Neptune is reached, students are typically excited about;

- How far it actually is between the planets
- How close the first couple planets are to each other and how far the others are.

Sample questions:

Q: Do you see how far Neptune is from the Sun? (You may have to speak very loudly)
A: About a football field (depending on scale). That is if the Earth is about the diameter of a human hair.

Q: It takes 6 months to get between Earth and Mars in a space ship. That's because a space ship at this scale is so small you would need a microscope to see it. How long do you think it would take to get to Neptune from Earth?
A: 12 years (Voyager)

Q: Now, how long do you think it would take to get to the nearest Star?
A: ~500 years with current technology.

Q: Do you know how far away the nearest star would be?
A: If the Sun is the size of a baseball sitting on home plate on a baseball field in Las Vegas, the nearest star, Proxima Centuri, would be in Vancouver, Canada. ~1300 miles away from Las Vegas. (Adjust for your location with a service like Google Maps)

4.3. The Wrap Up

The activity concludes with more questions and a handout/packet for participants which includes. Ideas for the handout are a "more resources" sheet designed to encourage self-study and table of solar system distances based on different size "Suns" from 5 mm to the size of a baseball (~75 mm) and the relative diameters of planets, moons and the Sun (printed on the pages that follow). We have also included stickers in the past and an "Experience Reminder". A small inexpensive souvenir that helps young participant remember the module experience. We have used sharks teeth, fossils, and (when available) NASA pins.

UNLV | Department of GEOSCIENCE

Nevada NASA Space Grant Consortium

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Part of Educational Experiences for K-12 in the Earth and Planetary Sciences Project.

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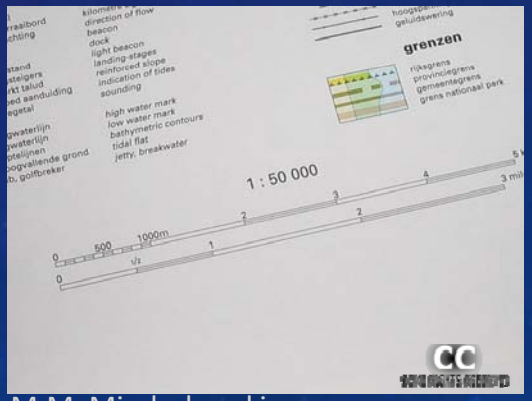
DIFFERENT SCALES

- What is a scale?
  - Weight Scale
  - Model (Ratio)
  - Map Scale

M.M. Minderhoud image

Scale model of a DC-3 airplane of Finnair. Photo by O-VMikkelä. CC 3.0



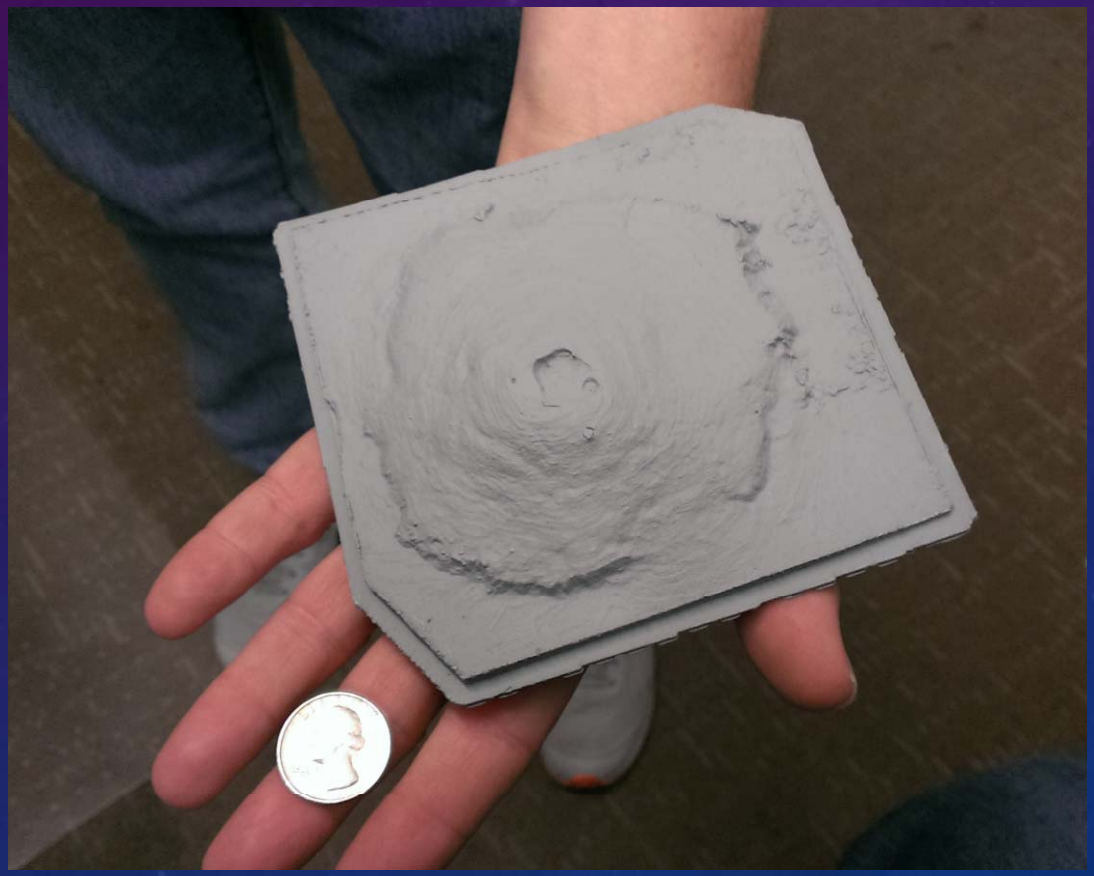
M.M. Minderhoud image

Scales tell us how big things are or how far away or how much they weigh! ***How big do you think the cliffs are in the picture?***

Now how big do you think it is? The child acts as a scale because we know about how large a child is. This is a "comparative scale".

SOLAR SYSTEM SCALES

- Scales are important in Space Exploration



3D printed scale model of Olympus Mons, the largest volcano in the solar system.

Scale Models help us study things that are either very small, very large, or rare.

3D model and Image by C.T. Adcock for NASA. Public Domain

SOLAR SYSTEM SCALES

- Scales are important in Space Exploration

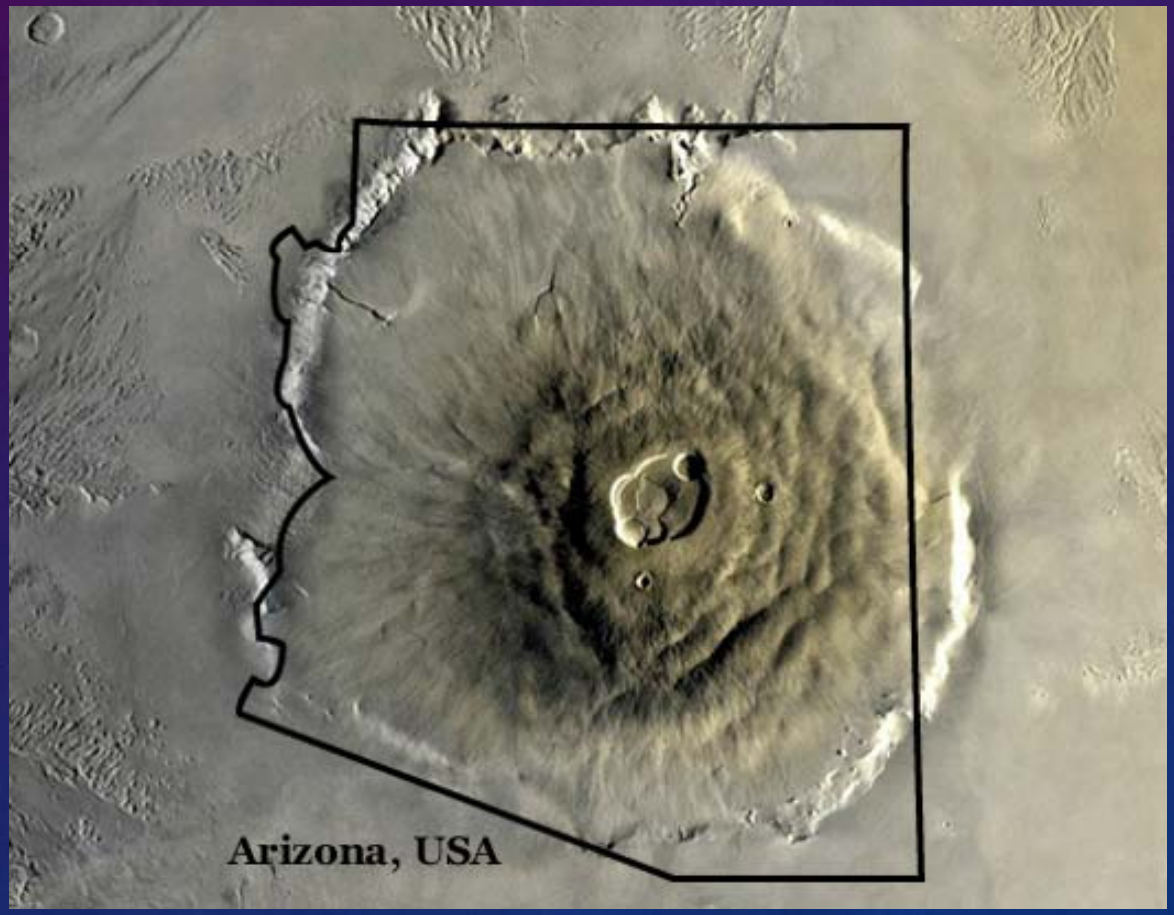
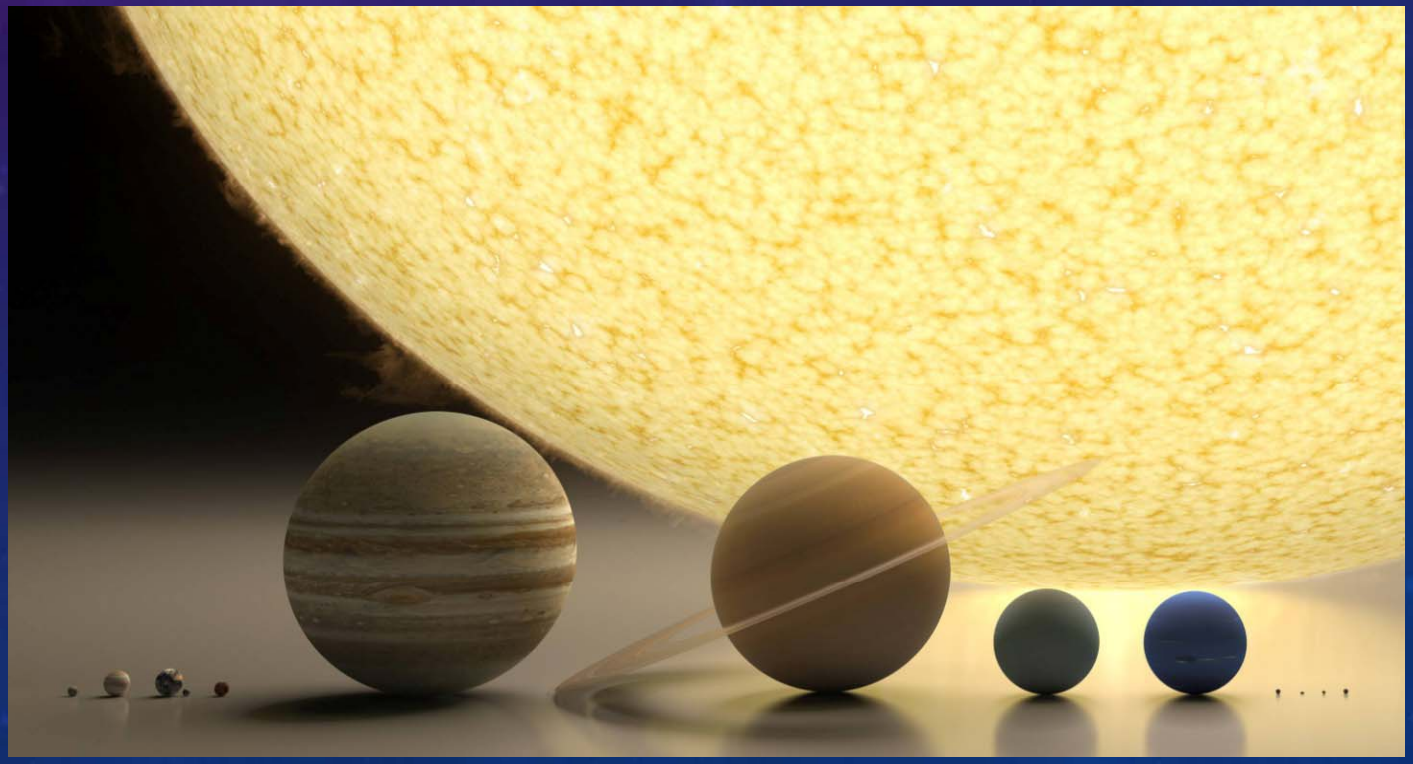


Image of Olympus Mons on Mars with Arizona Border over it. Arizona is about the same size as Nevada

SOLAR SYSTEM SCALES

- When we see planets in pictures, they all look like spheres and thus about the same size. The Moon looks about the size of the Sun.
- But we can scale them down and look at them all together.

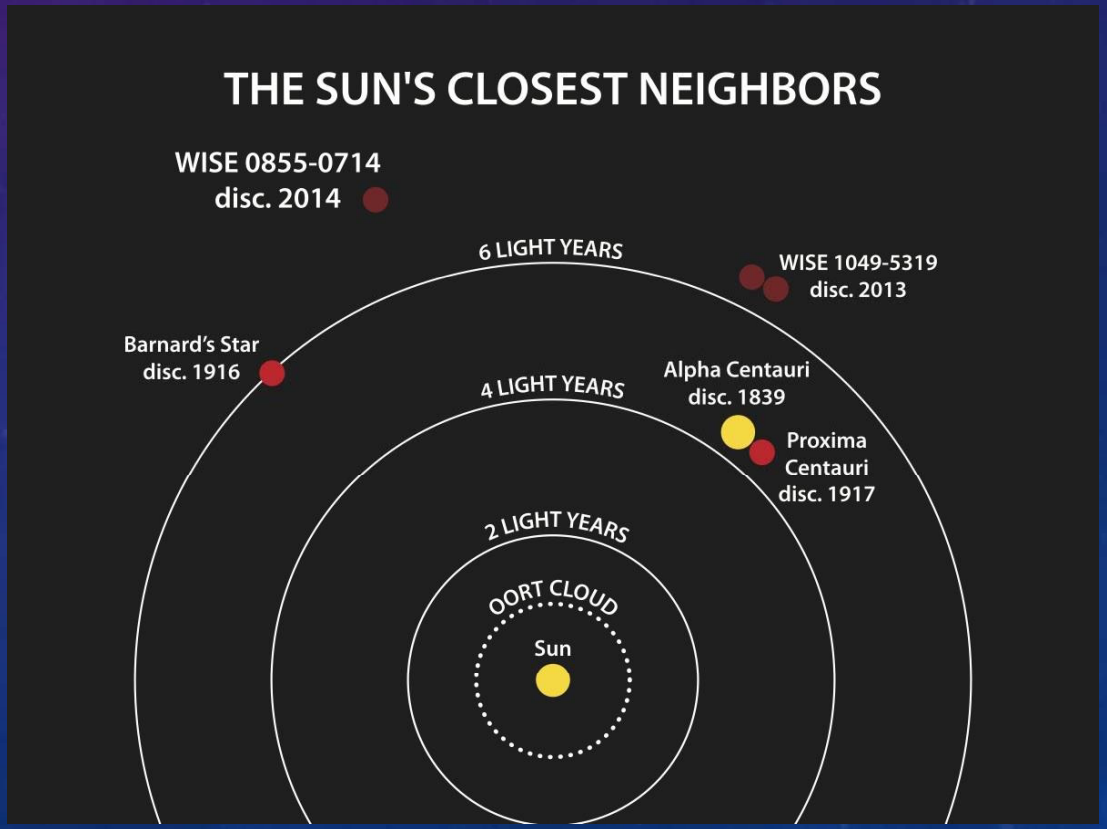
Do you know which one Earth is?



Roberto Ziche image with textures from NASA, planetpixelemporium.com and planetscapes.com. Used with permission from http://www.robertoziche.com

SOLAR SYSTEM SCALES

- Distances in space are so vast that they are hard to judge.
- The nearest star to our Sun is Proxima Centauri. It takes light over 4 years to travel there!

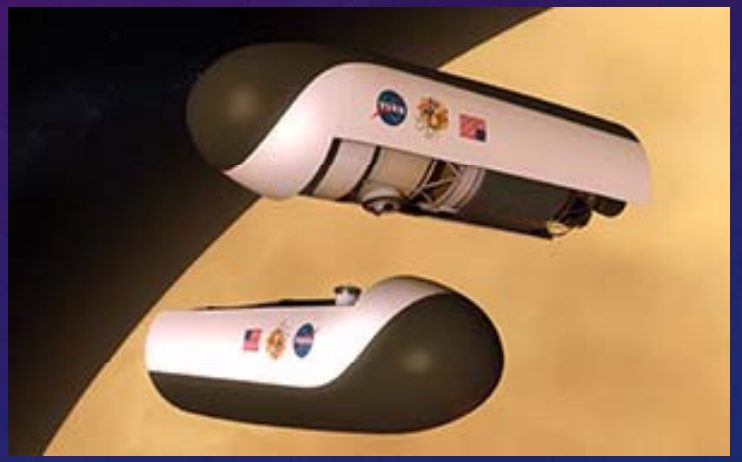


NASA/JPL/Penn State University Image PIA18003.
https://www.jpl.nasa.gov/spaceimages/details.php?id=PIA18003

SOLAR SYSTEM SCALES

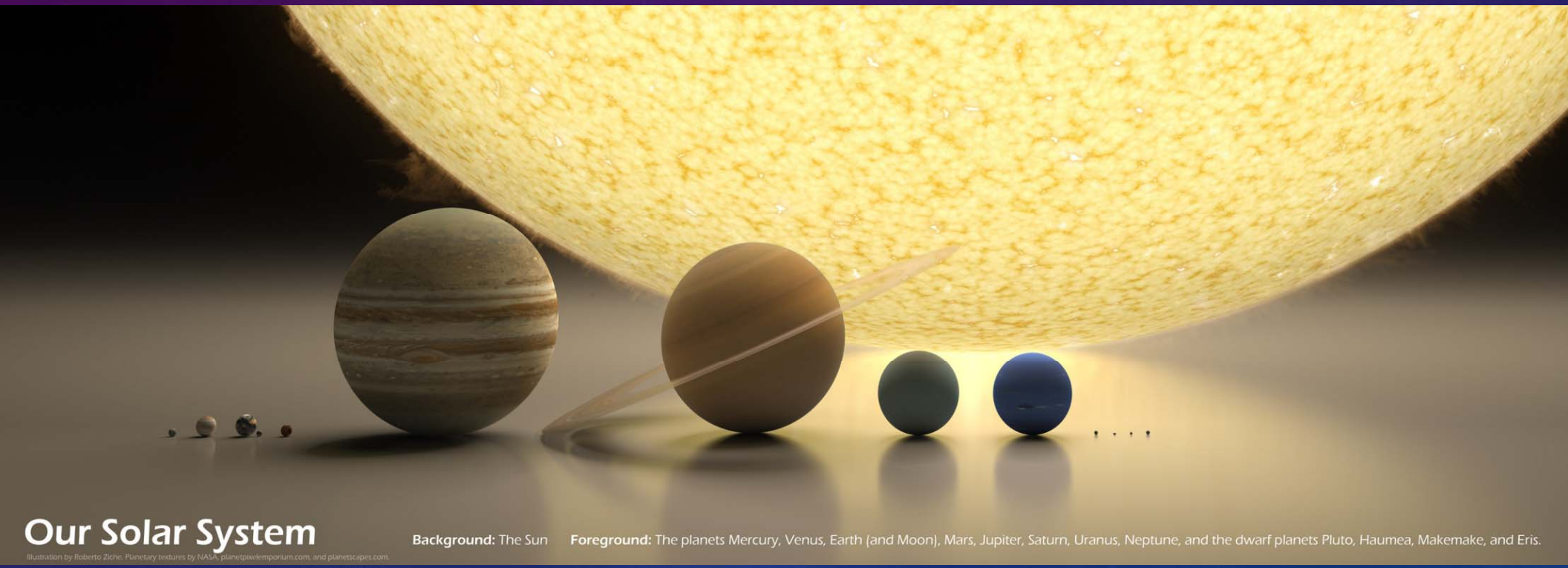
- When we send missions to other planets, we need to understand how far away the planets are.
- We use measures like “Light year” or “Astronomical Unit” or other scales, but they are hard to visualize.
- The reason it takes so long to get to other planets is because they are so far away.

- *But how far away are they really?*



Transport ships as part of Venus HAVOC mission. NASA Langley Research Center image.

LETS FIND OUT!



Roberto Ziche image with textures from NASA, planetpixelemporium.com and planetscapes.com. Used with permission from http://www.robertoziche.com

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Scales of the Solar System

True diameters and distances of the Sun and Planets

	Sun	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Diameter (miles)	*864,938*	3,032	7,521	7,926	4,222	88,846	74,898	31,763	30,778
Distance (miles)	0	35,983,610	67,232,360	92,957,100	141,635,300	483,632,000	888,188,000	1,783,950,000	2,798,842,000
Diameter (kilometers)	1,391,979	4,880	12,104	12,756	6,795	142,983	120,536	51,117	49,532
Distance (kilometers)	0	57,909,863	108,199,726	149,599,579	227,939,354	778,328,323	1,429,396,476	2,870,982,093	4,504,288,384

Scaled diameters and distances of the Sun and Planets

	If the Sun is:	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Diameter (inches)	*2*	0.006	0.018	0.018	0.010	0.200	0.168	0.068	0.066
Distance (feet)*	0	6	12	18	28	94	170	344	538
Diameter (inches)	*1*	0.003	0.009	0.009	0.005	0.100	0.084	0.034	0.033
Distance (feet)*	0	3	6	9	14	47	85	172	269
Diameter (inches)	*0.5*	0.002	0.005	0.005	0.003	0.050	0.042	0.017	0.017
Distance (feet)*		2	3	5	7	24	43	86	135

****rounded to the nearest foot***

Scaled diameters and distances of the Sun and Planets

	If the Sun is:	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Diameter (mm)	*51*	*0.152*	*0.457*	*0.457*	*0.254*	*5.080*	*4.267*	*1.727*	*1.676*
Distance (meters)*	*0*	*2*	*4*	*5*	*8*	*28*	*52*	*104*	*163*
Diameter (mm)	*25*	*0.076*	*0.229*	*0.229*	*0.127*	*2.540*	*2.134*	*0.864*	*0.838*
Distance (meters)*	*0*	*1*	*2*	*3*	*4*	*14*	*26*	*52*	*82*
Diameter (mm)	*13*	*0.038*	*0.114*	*0.114*	*0.064*	*1.270*	*1.067*	*0.432*	*0.419*
Distance (meters)*	*0*	*0*	*1*	*1*	*2*	*7*	*13*	*26*	*41*

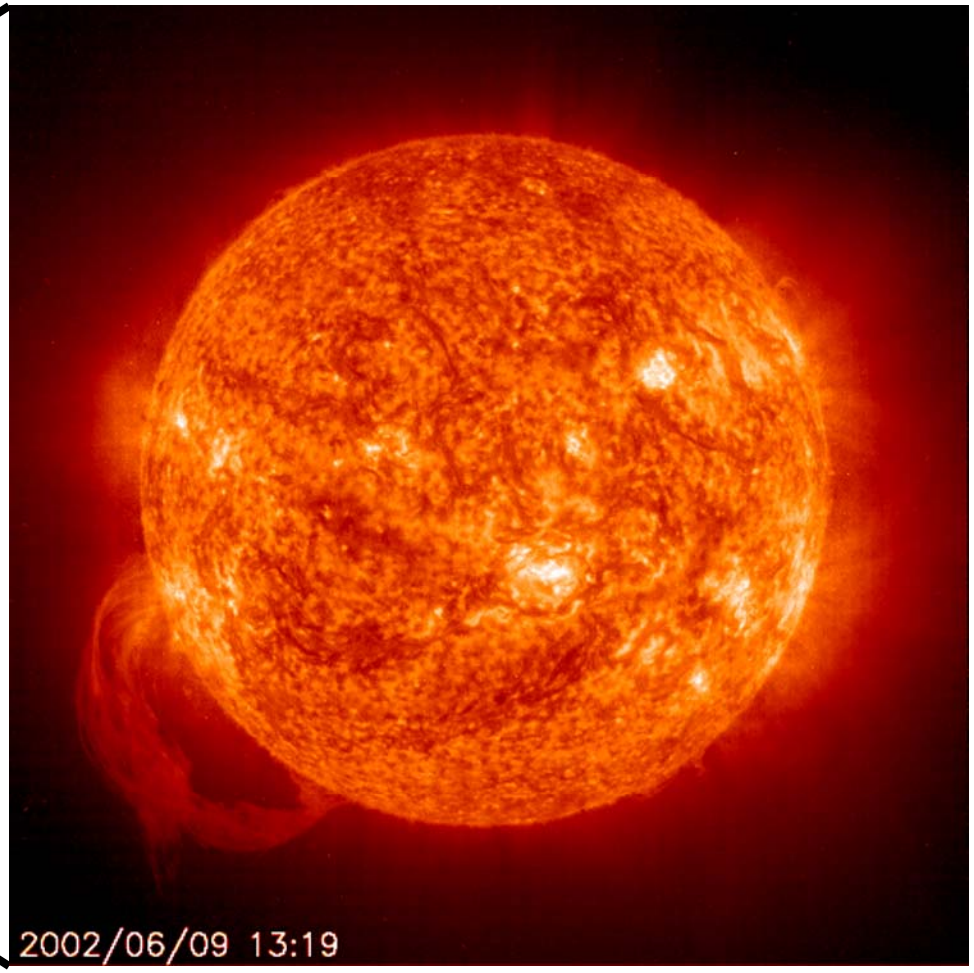
****rounded to the nearest meter***

See also:

http://www.exploratorium.edu/ronh/solar_system/

http://joshworth.com/dev/pixelspace/pixelspace_solarsystem.html

The Sun at
scale for exercise



Magnified 5 times

NASA Image PIA17669

Mercury at
scale for exercise
You can barley see it!

Magnified 10 times

Magnified 25 times

NASA Image PIA10172: MESSENGER's First Look at Mercury's Previously Unseen Side

Venus at
scale for exercise

Magnified 10 times

Magnified 25 times

NASA Image Magellan spacecraft radar data

Earth at
scale for exercise

Magnified 10 times

Magnified 25 times

NASA Image

Mars at
scale for exercise

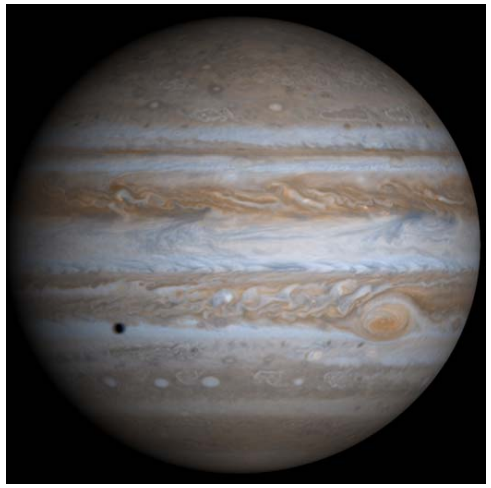
Magnified 10 times

Magnified 25 times

NASA Image NASA/JPL-Caltech/MSSS

Jupiter at
scale for exercise

Magnified 10 times



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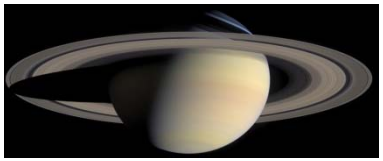
NASA Image NASA/JPL/University of Arizona

Saturn at
scale for exercise



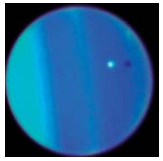
Magnified 10 times

Magnified 25 times

NASA Image NASA/JPL/Space Science Institute

Uranus at
scale for exercise

Magnified 10 times



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NASA Image NASA/Space Telescope Science Institute

Neptune at
scale for exercise

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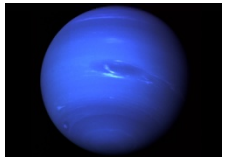

Magnified 25 times

NASA Image

EDUCATIONAL EXPERIENCES FOR K-12 IN THE EARTH AND PLANETARY SCIENCES

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For information, contact Christopher Adcock, adcockc2@unlv.nevada.edu

More Adventure and Resources:

Explore scales of the solar system:
http://www.exploratorium.edu/ronh/solar_system/
If the moon were only a pixel – what would the Solar System be like? Check it out here!
http://joshworth.com/dev/pixelspace/pixelspace_solarsystem.html