Drive-by Science

A series of quick activities for informal environments

Sun Scale and Distance

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Materials Needed:	Activity Time:	
2.5m diameter scaled Sun 23mm Earth marble 2 different sized Earth globes/balls	5+ minutes Age Group: 8-adult	

Background:

The scale of our solar system is difficult to imagine when we are standing on what appears to be a large planet looking at an apparently small Sun. Pictures don't help much. Although we could print the planet sizes to scale, the paper would need to be way too large to show the scaled distances. Instead, to help you understand the sizes and distances of our solar system, we've created a scale model.

Process

1. **Ask your audience if they know what a scale model is**. A scale model is a representation or copy of something that is larger or smaller than the actual object, but maintains the relative proportions. Use a toy car as an example. Objects can be scaled by distance as well as size.

2. **Show the audience your scaled Sun. Ask them what they think it is?**

3. **In our scale model, the Sun has been scaled down to 2.5m (8′). Ask participants how large they think the scaled Earth would be?** Show them the 3 model Earths and ask them to estimate which is the correct size for our balloon Sun [*23 mm blue marble*].

4. **Ask participants how far away should the Earth marble be placed to be in scale with the Sun balloon**. Make sure they understand that distance can be scaled with size, hence something scaled down to half as large would also be half as far away. Hand out some Earth marbles and have the students stand as far away as they believe the scale Earth should be placed. Accept all answers. Collect the Earth marbles.

5. **How could they figure out how far away to place their Earth marble?** First, warn the participants never to stare at the Sun. Ask participants to hold an arm straight out and use the smallest piece of their hand they can to cover up the Sun (by quickly glancing at it). What piece did they use? [*pinkie fingernail*] Now, have them hold up that same piece of their hand and try to cover up the Sun balloon. How far back would they have to walk to be able to cover the balloon with their little fingernail? (let them try to back up to figure it out…) [~270m, ~900′]

This works because in our scale model, all the proportions remain the same as the real Sun and Earth!

One could also use this opportunity to mention that, even at that great distance, the Sun gives the Earth warmth, light, energy, and helps sustain life.

If there is time, one could point out the sunspots on the model and describe what they are: temporary phenomena on the photosphere of the Sun that appear visibly as dark spots compared to surrounding regions. They are caused by intense magnetic activity, which inhibits convection, forming areas of reduced surface temperature. They usually appear as pairs, with each sunspot having the opposite magnetic pole to the other. A less-accurate but better understood description of sunspots is "magnetic storms on the Sun".

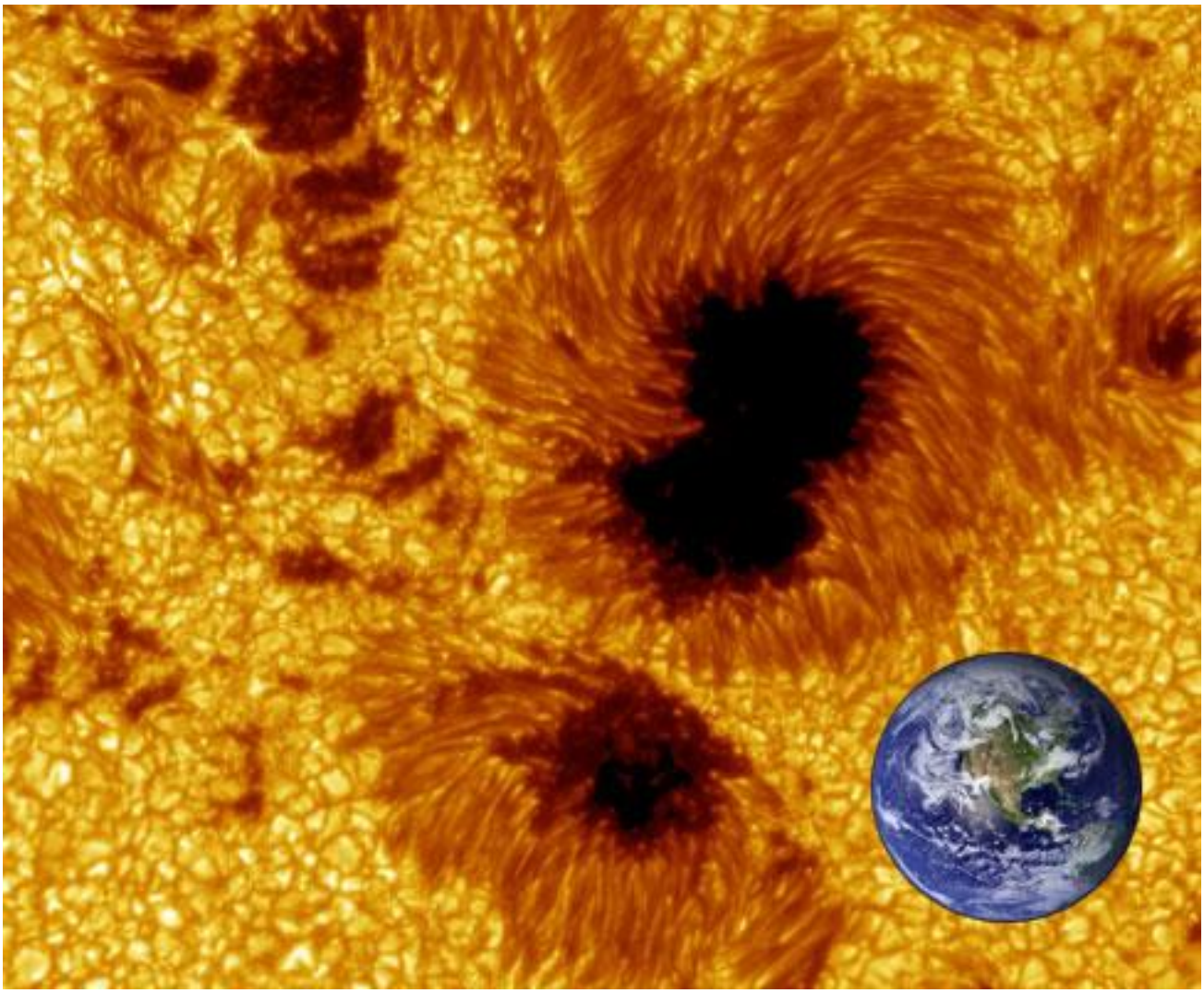


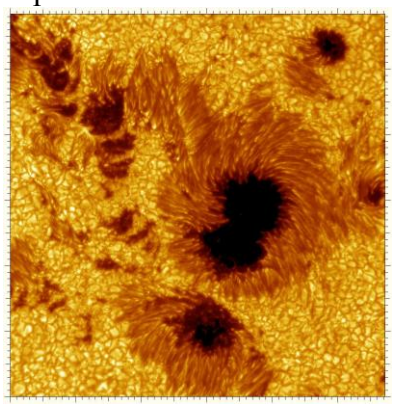
Image courtesy of NASA

Developer's Notes for Solar System Scale Model

Scaled Sun – 2.5 m (8′) diameter. Cost: few dollars to many hundreds

Note: the Sun is white (not yellow or orange, which is a misconception). See http://solar-center.stanford.edu/SID/activities/GreenSun.html

An inexpensive ($<10), one-dimensional Sun can be cut out of a plastic paint tarp or butcher paper. If you are working with young children, have them dip their hands in paint and make hand prints on the Sun. They could be shown imagery of sunspots, discuss them, and imagine their prints represent sunspots.



Weather balloons ($25-$75) do give an impressive 3-D look. But since they are designed to explode at high altitudes, they are quite fragile for use around children.

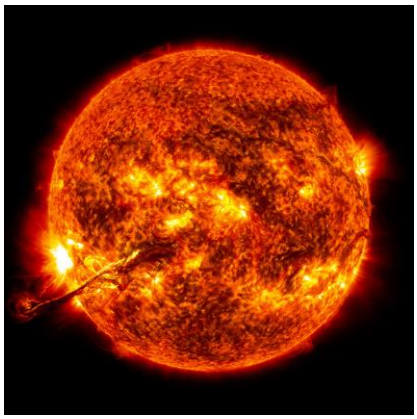
Vinyl balloons can be custom-made by companies who make advertising balloons ($300-$400). Straps can be added for anchoring. It is possible to paint sunspots on the vinyl (we had a sunspot researcher here at Stanford paint our spots). The vinyl balloon was not too hard to carry around in a suitcase and easily inflatable by a hair dryer.

Stanford Solar Center's custom-made vinyl balloon Sun

Image by Mike Reid

Vinyl balloon manufacturers are now able to use imagery from NASA's STEREO twin spacecraft to produce printed vinyl balloons. This increases the cost significantly ($800-$1000). The balloon to the left was produced for Mike Reid, using imagery from NASA's STEREO twin spacecraft.

Another option is to have a 2.5 m (8′) diameter flat image of the Sun produced on vinyl paper similar to that used for scientific posters. Add grommets for hanging. The poster is less costly ($300-$400) than the vinyl balloon, and more colorful (though less impressive than the 3D). The poster Sun is easy to fold and carry around. Outstanding solar imagery is produced by the AIA instrument aboard NASA's Solar Dynamics Observatory. http://sdo.gsfc.nasa.gov/data/



Earth globes to compare your Sun to. Cost: a few dollars

You'll need 3 example Earths of different sizes to ask your audience which might be the correct scale for your 2.5 m (8′) Sun. You could use an inflatable beach ball/Earth globe as the largest, 300 mm (12) is good, inexpensive and available on the net. For the medium size, perhaps use the small stress-reliever globes, also available on the net. For the tiniest, you will need one of the Earth marbles that will also represent the Earth in your scale model. More info on that below.

Earth Marble. Cost: a few dollars

Gorgeous Earth marbles (23 mm; .9″) are available on the web, made from recycled glass and using 6 colors. Continents are clear, rivers and mountains are visible. Our favorite Earth marbles come from Shasta Visions™. Having these exquisite Earths to show audiences really excites them. These marbles often disappear, so plan to have extras on hand. Note – the Earth marbles come in several sizes. For this scale, make sure you get the 23 mm ones.

If you wish to add a Moon to scale, use a 6 mm (1/4") clear or grey marble.

Going Farther

1. **Actually place the Earth at its scaled distance**
   On this scale, the Earth marble should be placed 270 meters (887') from your Sun.

2. **Draw the Earth's orbit on a satellite map of the area**
   We have also printed off satellite images of the area where we were setting up the scale model. Then we drew the orbit of the Earth on the map, with the Sun in the center at our location. People very much enjoyed looking at the maps!

3. **Place the Earth at its scaled distance from the model Sun and observe it through a telescope**
   If a telescope or monocular or binoculars are available, place your scale Earth on top of something like a roof or antenna that is about 270 m (887') away from your model Sun. Point out the location to the kids (after they estimate where they think the model Earth ought to be) and let them look at the Earth through the telescope. You'll need a tripod for the scope.

4. **Do a full scale model, complete with the other planets, asteroids, and Kuiper Belt.**
   Instructions on how to do this are available at
   http://solar-center.stanford.edu/activities/ScaleModel/

