

## Some General Suggestions

- Research topics you are presenting to learn about the common misconceptions (see below!)
- Always address how science knows what it knows – share the evidence so that science is accessible and not a “black box”
- Share science as a continuing story of discovery to help the public better understand the process of science; share what is unknown and invite the public to be part of the exploration
- The popular press and NASA should get a jump on misconceptions; explicitly address them – early!
- Help audiences connect to Nature so that they are aware of changes and ask questions (e.g., apparent changing path of the Sun through the year, phases of the Moon, etc.) Get them outside!
- Create a tool box of demonstrations to address specific misconceptions (hands-on, visual, quick, topical)

## The Moon

### Common Misconceptions

- The Moon is only visible at night time; it is not “up” during the day
- Earth’s shadow causes phases of the Moon
- Clouds cause the phases of the Moon
- Earth has few impact craters because the Moon protects it

### Strategies

- *Lunar phases are caused by clouds or the Earth’s shadow*

Invite students to observe the Moon over several weeks; how do their observations compare to cloud cover?

Use hands-on modeling experiences; can the students create a model of lunar phases that demonstrates that Earth’s shadow causes lunar phases?

- *Earth has few impact craters because the Moon protects it*

Build a model of the Earth and Moon with appropriate sizes and distances (tennis ball Moon, basketball Earth at a distance of 24 feet). Have the Moon orbit Earth. Throw candy or other "asteroid" objects at the Earth; is it possible for the Moon to protect Earth?

Share images of impact craters on Earth (and other planets). Explore why Earth's record of impact craters is "revised. Plate tectonics recycles much of the crust; erosion erases craters, oceans cover much of the crust; these processes are not occurring on the Moon.

Research on teaching about Moon phases and eclipses:

<http://aer.noao.edu/cgi-bin/article.pl?id=138>

## **Seasons**

### Common Misconceptions

- Seasons change because our distance from the Sun changes
- Seasons change because Earth's tilt changes
- Seasons change because the length of the day changes

### Strategies

- *Seasons change because our distance from the Sun changes*

Have the audience safely take or view photographs of the Sun to demonstrate that the Sun is bigger/closer in the winter than the summer

Invite students to research a vacation (temperature, day length) in different locations in the northern and southern hemispheres for different times; have them share pictures of their vacation spots. Have them compare data and develop a model to explain the seasonal differences.

Research on misconceptions about the seasons:

<http://www.mos.org/nessie/education-research.php>

The Real Reasons for the Seasons (activities for grades 6-8):

<http://www.lawrencehallofscience.org/gems/GEMSSeasons.html>

## **Solar System Scale**

### Common Misconceptions

- The Moon is very close to the Earth
- Planets are big and close together (illustrations in books and exhibits often show big planets in small orbits)
- The Sun is small
- Stars occur in our solar system inside the orbit of Pluto

### Strategies

Invite audiences to predict and *then* manipulate experiential models

Models should correctly illustrate distance *and* planet size

Check out the Exploratorium's "Build a Solar System" to automatically calculate distances and sizes for any scale:

([http://www.exploratorium.edu/ronh/solar\\_system/](http://www.exploratorium.edu/ronh/solar_system/))

Models should include orbit paths so that planets are not always in a straight line

"Size" can mean different things to different people. Help audiences understand concepts of distance, area, volume, density in a conceptual way (beyond equations)

Expand the Solar System (!) to include the Kuiper belt and Oort cloud as audiences commonly are unaware of these components.

Demonstrate how far away objects – such as other stars - would be using scale models.

If our whole solar system was the size of a quarter, the "next nearest" star - Proxima Centauri – would be two soccer fields away. At this scale, our entire Milky Way galaxy of stars would be the size of the United States.

If the entire Milky Way galaxy was the size of a CD, the nearest spiral galaxy – Andromeda - would be another CD about eight feet away.

Educational research and teaching and learning resources for the solar system and beyond:

<http://cfa-www.harvard.edu/seuforum/btss/>

## **Lunar Exploration**

### Common Misconceptions

- Gravity boots are needed to keep astronauts attached to the Moon
- There is no gravity in space
- We never went to the Moon
- Where is the hardware we left behind if we really went?
- The Space Shuttle goes to the Moon
- People cannot pass through radiation belts
- People are aboard unmanned space craft
- There is no benefit to returning to the Moon
- Why go back ... been there, done that ... the money can be spent on other things
- If we can put a man on the Moon, why can't we .....

### Strategies

Make the Moon real! Get the public outside to look at it!

Give the public a vested interest in returning to the Moon

Science (lunar science, Earth observations, views beyond), resources, inspiration!

The Moon is a test bed for further exploration and discovery; nations that invest in exploration have flourished.

Exploration drives invention (and vice versa); our technology will advance and benefit our lives (e.g., may help us develop a strategy for near-earth-approaches by asteroids).

Share the *story*; what do we know? What do we hope to learn? There is a necessary investment in science and engineering to achieve results. New answers will generate new questions.

Debunking the Moon Hoax:

<http://www.badastronomy.com/bad/tv/foxapollo.html>

Research on teaching about the Earth's shape and gravity:

<http://aer.noao.edu/cgi-bin/article.pl?id=65>

## **Mars**

### Common Misconceptions

- Mars is hot (after all, it is red and desert-like)
- Mars has no water or atmosphere
- Mars has hot springs
- Mars has erupting volcanos
- Human missions have been to Mars
- We have brought Mars rocks back to Earth
- Mars is bigger than Earth
- Mars was as big as the Moon during its close approach last year (shared through e-mail)

### Strategies

- *Mars is hot*

Does red mean hot? Apples are red.

## **Stars**

### Common Misconceptions

- The Sun is not a star
- Jillions of stars are in our solar system
- "Light year" is a unit of time
- The solar system, galaxies and the Universe are thousands of years old

### Strategies

Learning resources and activities for "beyond the solar system:"  
<http://cfa-www.harvard.edu/seuforum/learningresources.htm>

## **Other Misconceptions**

- The aurora is a forest fire, nuclear war, and/or alien space ships attacking Earth
- Science is not a creative, dynamic endeavor (the answers are known)

- Scientists make up their data to make money
- Science is a religion
- Does NASA and the science community have misconceptions about public expectations of NASA and space exploration/development /commercialization (e.g., vicarious exploration through astronauts and robots versus possibility of space tourism)?