

# WHY DO WE PUT TELESCOPES IN SPACE?

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*What's the Activity About?*

## **SUGGESTION:**

- ***View the Training Video for suggested ways to demonstrate this.***

**Big Question:** Why do we put telescopes in Space?

**Big Activity:** Investigate simulated atmospheric conditions through mock telescope

**Participants:** Adults, teens, families with children 6 years and up

If a school/youth group, 3<sup>rd</sup> grade and higher

From one participant to 2 groups of 3 participants. Limitation is due to quantity of resources provided in the ToolKit. Up to 3 people can share a tube telescope.

If you want more groups, you can supply more tube telescopes and atmosphere (bubble wrap) – See the sections “*Helpful Hints*” and “*Where do I get additional materials*”.

**Duration:** 20 minutes

### **Topics Covered:**

- How the atmosphere limits our ability to view the heavens from the surface of Earth
- Benefits of placing telescopes in space

### **Activities:**

Experiment with mock telescopes and materials that simulate atmospheric conditions

### Helpful Hints:

For more than about 10 people, you will need to acquire more telescopes (paper towel tubes are fine), clouds (cotton balls), small flashlights, and more atmosphere (bubble wrap) and rubber bands. For the “mystery object” you may want to use a larger object than the small ball, such as a colorful, decorated balloon or ball (as shown in the photo at the right) and cover it with a towel until everyone is ready to view it.



If you are doing this inside and have access to a computer projector, you can use the TelescopesInSpace.ppt (PowerPoint presentation) found in the *Multimedia Gallery* folder on the PLANETQUEST OUTREACH TOOLKIT MANUAL AND RESOURCES CD in the *PowerPoints* sub-folder.

Using an overhead projector, you can project an image of a celestial object (for instance, the image of M16, the Eagle Nebula provided [here](#)) on a screen to use as the “mystery object”, as shown in the photo above. Print the image on a transparency (if you do not have the equipment at home to do this, your local copy shop can do it for you).

If you are outside and have a laptop computer, you can display a photo of a celestial object on your computer screen for the “mystery object”.

Another option is to make separate stations with full sets of materials at each station. A presenter will need to be at each station.

*This activity can be done in these locations:*

- Outside in the early evening or at night (not as effective outside during the day – you need a very shaded location)
- Inside at night
- Inside during the day where you can darken the room at least to the level of twilight.

### Background Information:

There are two primary factors why we put telescopes in space:

1. Effects of the atmosphere: distortion, light pollution, weather, daylight
2. Only limited bands of the electromagnetic spectrum can penetrate our atmosphere: mainly radio and optical radiation (kinds of light). Infrared, ultraviolet, etc are almost completely absorbed as they pass through our atmosphere.

#### NOTE:

This activity only illustrates the first factor: the effects of atmospheric distortion, light pollution, and daylight that affect our ability to view the sky. This activity does not cover types of light other than optical due to limitations of materials needed to illustrate this. If you are interested in activities and discussing how the atmosphere limits our ability to detect infrared, UV, and so on from outer space, please refer to:

<http://www.ipac.caltech.edu/Outreach/Multiwave/activities.html>

For more information on the effects of the atmosphere:

<http://spaceguard.ias.rm.cnr.it/tumblingstone/issues/num8/tele/tele-atmo.htm>

More about Telescopes in Space:

[http://earthsci.terc.edu/content/data\\_centers/es2806.cfm?chapter\\_no=datacenter](http://earthsci.terc.edu/content/data_centers/es2806.cfm?chapter_no=datacenter)

To subscribe to **satellite pass predictions** by email – to allow your visitors to watch for telescopes in space or other satellites:

<http://science.nasa.gov/RealTime/JPass/PassGenerator/>

### **Adaptive Optics:**

Of course, adaptive optics assists with improving the view from ground-based telescopes, but the precision required to find small planets around other stars can be best achieved in space.

For more on the Keck Telescope and adaptive optics:

[http://planetquest.jpl.nasa.gov/Keck/keck\\_technology.html](http://planetquest.jpl.nasa.gov/Keck/keck_technology.html)

### **Earth's atmosphere:**

In this activity, we use a piece of bubble wrap to represent Earth's atmosphere. All the weather in our atmosphere occurs within 10 miles of the surface of Earth – the lowest 10 miles of the atmosphere. Commercial airplanes fly about 7 miles high. 80% of the atmosphere is in that first 10 miles. On the scale used in this activity, that is only a bit thicker than a regular piece of paper. As you ascend out from the surface of Earth, the atmosphere gets thinner and thinner – above 300 miles (represented by the thickness of the bubble wrap) the atmosphere is so thin it no longer has much influence on degrading the orbit of satellites.

A common question you may get is “How high is Mount Everest?” – it is roughly 5 miles high. That's why it is so difficult to breathe up there.

This is one reason why we put telescopes on top of high mountains – like the Keck telescope in Hawaii - the air is thinner and so there is less interference from the turbulence of the atmosphere.

Detailed Activity Description

Leader's Role	Participants' Roles (Anticipated)
<p><b>INTRODUCTION:</b></p> <p><u>To Ask:</u> Who has heard of the Hubble Space Telescope? What is it? (a telescope in space) NASA is putting telescopes out in space for many purposes. In the next 15-20 years, some will be sent up to find Earth-size planets around other stars. Why do you suppose we put telescopes out in space? What is it about being down here on the surface of the Earth that interferes with our ability to see things clearly in outer space? How does our atmosphere interfere with our ability to see the things in outer space?</p> <p><u>To Do:</u> Holding out the globe, ask your visitors to guess how thick the Earth's atmosphere is compared to the inflated globe.</p>	<p>Discuss ideas (e.g. rain, clouds, light pollution, sunshine, wind)</p> <p>Indicate with their hands how far away from the surface of Earth the atmosphere extends.</p>
<p><u>To Model:</u> Take a piece of bubble wrap and lay it flat on the surface of a globe.</p>  <p><u>To Say:</u> This bubble wrap represents our atmosphere. Satellites are put in orbit above 300 miles – this is about the height where the atmosphere no longer has much influence on degrading the orbit of satellites. Our atmosphere is very thin compared to the diameter of our planet, which is about 8000 miles in diameter.</p> <p><u>To Do:</u> Ask your visitors to pick any two cities on the globe that are about 300 miles apart and show that the bubble wrap is about as thick as the distance between the cities. (e.g. San Jose and Los Angeles in California).</p>	<p>Listen and observe.</p>

To Do:

Wrap the piece of atmosphere bubble wrap around end of tube telescope with the bubbles facing out. Secure with a rubber band.



To Say:

This represents looking at the sky with a telescope through the atmosphere from the surface of Earth.

To Do:

Place all other materials on the table.  
Place the small “star” (the snake light with its hood off) about 10 feet away. If you are inside, turn out (or down) the lights.

To Say:

We can simulate some of the effects of the atmosphere. Air is constantly in motion with all of its many layers moving around.

To Ask:

What do you notice?

Participants look at the mock star through the tube telescope and move the tube around slightly.

Participants volunteer their observations.

To say:

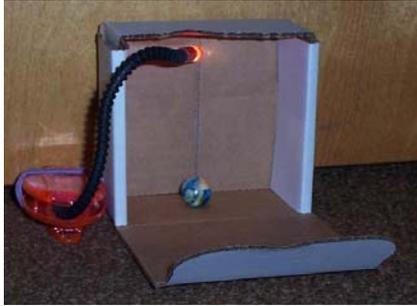
Experiment with other things that can interfere with our ability to see out into space.

IF YOU ARE OUTSIDE IN THE DARK, pick a star near the horizon and ask what the participants notice about the star. (twinkling).

Participants place the cotton “clouds” in front of the telescope. Shine the “city lights” flashlight toward the end of the tube (keeping the light slightly to the side of the tube). Breathe on the bubble wrap at the end of the tube (fog). Discuss how the image of the mock star is affected.

If you are INSIDE, turn the lights on full bright.  
If you are OUTSIDE, turn the big flashlight on and aim it at the end of the tube.  
SAY: Now, what happens every morning? The sun just rose.  
Can you see stars in the daytime?

DO: Place a “mystery object” (such as a marble or other object) in a box with a light shining on it. (See [Helpful Hints](#) section for additional ideas for the mystery object)



Turn off the lights (or the big flashlight). Have the participants look at the object through the tube with atmosphere. (No peeking without the tube telescope)

ASK: Describe what you are looking at. What do you notice? What kind of detail can you see?

SAY: Let’s go up above the atmosphere and see how the view changes.

DO: Take away the atmosphere from the front of the telescope, and leave the “star” on.

Have the participants look at the star and at the object without the atmosphere on the tube (from above the atmosphere).

ASK: Now what can you tell me about the object you saw?

SAY: If we fly up above the atmosphere, is the sky dark or light? (Dark – this works better outside) The atmosphere scatters the sun’s light and when you get above the atmosphere, even if you can see the sun, you can still see stars.

ASK: So why do we put telescopes in space?  
(Atmosphere scatters light, has weather. Out in space, we have nothing in the way. We can observe at any time. There is no day and night in outer space.)

SAY:  
The Hubble Space Telescope is capable of producing photos Earth-based telescopes cannot produce.

DO: Show comparison images of ground and space photo of [Eagle Nebula](#)

SAY: All planets discovered to date have been large Jupiter-sized planets detected from Earth-based telescopes. The precision required of the NASA missions to find the much smaller Earth-size planets around other stars, SIM (Space Interferometry Mission) and TPF (Terrestrial Planet Finder), can only be achieved in space.

Give descriptions of what they see

Describe object

Discuss this idea

Discuss ideas

## ***Materials:***

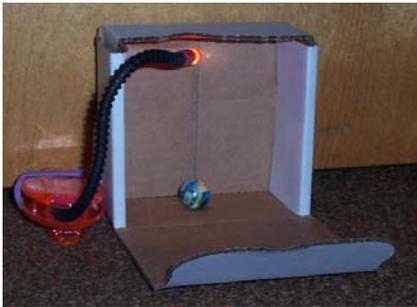
### *What Materials from the Outreach ToolKit do I need?*

- Tube mock telescopes
- Bubble wrap (atmosphere)
- Snake Light (with hood removed) for a star
- Snake Light (with hood attached) to light up object in box
- Small multi-colored ball (“mystery object” placed in box to identify)
- Box 4” x 4” x 2” (same box as used in the Galaxy Model activity)
- Cotton ball (clouds)
- Small squeeze flashlight (city lights)
- Rubber band
- Image comparing [ground-based vs Hubble photo](#)
- 1 World globe – 12 - 14 inches in diameter
- Labels (See “[Item Labels](#)” below)

**OPTIONAL:** “Why do we Put Telescopes in Space?” PowerPoint (TelescopesInSpace.ppt). This is found in the *Multimedia Gallery* folder on the PLANETQUEST OUTREACH TOOLKIT MANUAL AND RESOURCES CD in the *PowerPoints* sub-folder.

### *What do I need to prepare?*

- Place batteries into the snake lights
- Box – fold the 4”x4”x2” box
- Attach the marble (or other object) with a small bit of clay inside the box as shown below.



- To show the [ground-based vs Hubble photo](#), you may want to either print it out, print it as a transparency for use with an overhead projector, or use the image from the TelescopesInSpace.ppt PowerPoint found in the *Multimedia Gallery* folder on the PLANETQUEST OUTREACH TOOLKIT MANUAL AND RESOURCES CD in the *PowerPoints* sub-folder.

See “[Helpful Hints](#)” for additional ideas.

### What must I supply?

- 1 Large flashlight (the Sun) – not needed if this is done indoors

### Where do I get additional materials?

- Tube mock telescopes: Paper Towel tubes – ask your club members to save them and bring them to the club meetings.
- Bubble wrap: save bubble wrap packing materials – be sure they are the small (1/2” or smaller) bubbles. You may have someone in your club with access to packing materials. Or from an office supply store.
- Snake light: Order from Oriental Trading Company 800-526-9300 or at <http://www.orientaltrading.com>. Order Item # 50/80 Transparent Snake Book Light
- Small flashlight: These may be available at hardware stores, but another source is Quantum Promotions. They will sell as few as 10 flashlights at once. They refer to these as "sample" shipments. You can order them by any of these methods:  
EMAIL: sales@quantumpromotions.com or contact the sales rep, Steve Tallman, at: stallman@quantumpromotions.com.  
FAX: 510-420-1930.  
CALL toll free at: 1-877-776-6674.  
For 10 squeeze flashlights, the quoted price as of June 2003 is \$3.28/ea, plus shipping.
- 12”-14”World globe: Bookstores and school supply stores carry globes; for inexpensive inflatable globes, try Oriental Trading Company 800-526-9300 or at <http://www.orientaltrading.com> . Order Item #IN-49/1290.
- Box: You can use almost any small box: a shoe box, a gift box

### Item Labels

Telescope

Atmosphere

City Lights

Clouds/Fog

Star

# WHY DO WE PUT TELESCOPES IN SPACE

View from the Auckland Observatory in New Zealand  
(on the surface of the Earth)

View from the Hubble Space Telescope  
(above the Earth's atmosphere)

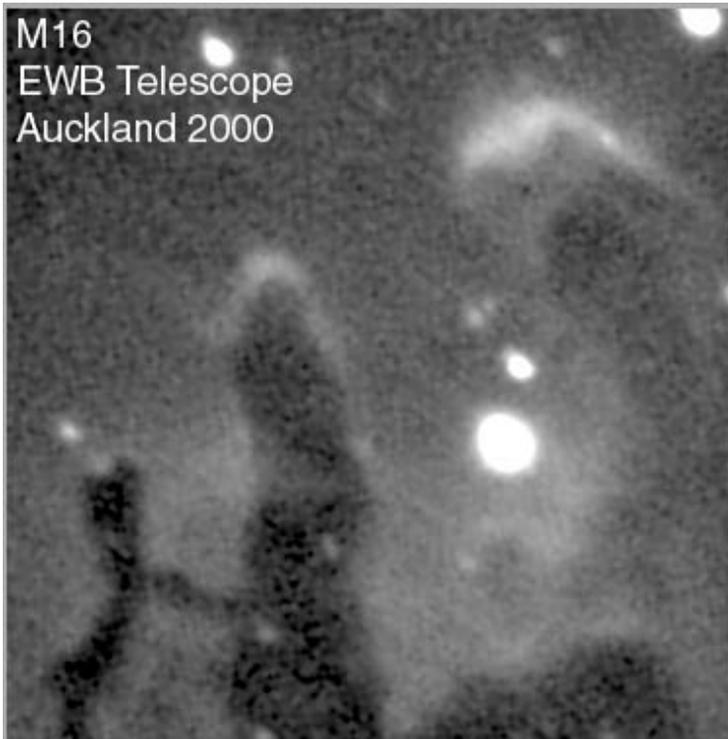


Image courtesy of Dr. Ian Griffin and the Auckland Observatory

Image from NASA and Space Telescope Science Institute

## *Comparison Image of the Eagle Nebula (M16)*

*“Mystery” Object*

