WHAT DOES THE UNIVERSE LOOK LIKE?
Challenge: Create a group portrait of the universe.

It's a big universe out there. What does it look like?

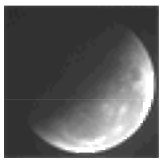
Use the telescope to image *different kinds* of objects in the night sky: the Moon, a planet such as Jupiter or Saturn, a "nebula" such as the Orion nebula, and one or two galaxies.

Then create a "group portrait" of the universe. In a group portrait, the tallest people are usually in the back. In your group portrait of the universe, try arranging your images from the closest to the furthest object. From the youngest to the oldest. From the smallest to the largest.

GOALS OF THIS ACTIVITY:

- Gain facility using the telescope. Early assured success, but as challenging as desired.
- Get the "big picture" of the universe and what's in it.
- Sort out students' prior conceptions about what's in the universe.
- Opportunity for students to pose questions to motivate future projects.
- Introduce concept of angular size and its connection to size and distance.
- Introduction to image processing if desired.

DISCUSSING YOUR IMAGES



MOON:

Which direction is the Sun in your image? Why do you think that?
The Sun is the source of light for the Moon. The Moon is shining by reflected light.

What do you think the craters on the Moon are from?
Impacts of asteroids, early in the Moon's history.

Why isn't the Earth covered with craters too?
They have almost all eroded away. But a few are still visible.

A tough one: If the Moon craters are from impacts, then why are there mountains in the centers of some of the craters?
See Craters project, and compare with Harold Edgerton's famous "milk drop" photo. An asteroid impact melts the underlying rock.

Why did you have to use a deep grey filter?
To cut down on the light: The moon is so bright, you would need an exposure time shorter than the telescope can handle.

Why don't you see stars in the background?
The moon is so bright that the exposure must be short. Therefore, the stars are underexposed.

An image of the Earth and Moon, seen from space, is superimposed on a separate Hubble telescope image of the background sky. Two very different exposure times wee required.

JUPITER

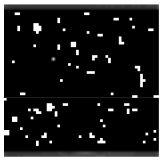
If Jupiter (or Saturn) is a big planet, why does it appear so much smaller than our Moon?
Because it is much further away.

Why don't you see any stars in the image of Jupiter?
Jupiter is so bright, the exposure must be short. Stars are underexposed.

Can you detect any of Jupiter's moons?
Your image should contain two to four Jupiter's innermost four moons.

If you took several exposures of Jupiter over time, would you expect to see the moons moving?
Yes, over four or five hours you will see the innermost two moons move detectably in that time. (See Voyage to Europa activity.)

What is the source of light for Jupiter and its moons? Why do we see them?
Like all planets and moons, Jupiter and its moons REFLECT light from the Sun. They don't produce their own visible light.



STARS

Why do the stars appear as tiny dots?
Stars are so far away that they appear as dots even in the most powerful telescopes — even the Hubble Space Telescope!

Then why are some of the dots wider than others? Are those stars larger?
No. If stars could be imaged exactly, then EVERY star would be less than 1 pixel wide, because they're so far away. But because the telescope is an imperfect machine, the stars get imaged into disks. The largest dots correspond to the BRIGHTEST stars, not the largest stars.

Could I ever see planets around those distant stars, using the telescope?
Planets around distant stars are so faint and so small that no telescope in the world can yet image them. But there are indirect ways of telling they're there. (See student project, "Extra-Solar Planets".

Do the stars emit their own light, or are they reflecting light from some other source?
Sure, they emit their own light, the same as our Sun, our own star.

In ancient times, people thought the stars were on a giant sphere, all at the same distance from Earth. Do you think that the stars are all at the same distance from Earth? Can you tell whether they are just by looking at your images?

The stars are at different distances from Earth, but you can't tell that just by looking at your images. Some stars look dimmer than others so they SEEM further away; but perhaps thosestars are inherently dimmer, like a lower wattage bulb. (See the investigation, "To the Stars!")

What would it look like if you live near the center of one of the globular clusters of stars?
There would be so many nearby stars that the sky might never get dark at night.

Do you see more stars in certain directions of the sky than others? Why do think?
Images taken in the direction of the Milky Way (low declinations) should show many more stars than images taken towards, say, the North Pole. That's because stars in our galaxy form a giant pinwheel shape.

NEBULAE

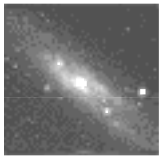
How do the nebulae in your images compare in size to the Moon's image?
The Orion nebula and others can be as large as, even larger than, the width of the Moon.

If the nebula appears as large as the Moon, then why don't we see it in the night sky?
It's too faint. Many beautiful objects in the sky — such as nebulae and galaxies—would be large enough to see with our naked eye, if only they weren't so dim! The telescope aids us by gathering light from dim objects:

How does your exposure time for the nebula compare to the exposure time for the Moon?
The nebula takes a longer exposure time, because it is so faint. And not only is the Moon's exposure so faint, you also need a deep grey filter to cut down even more of the Moon's light!

Tough one: Does the nebula glow with its own light, or reflected light?
Some emit their own light, while some we see only because they reflect light from nearby stars. See the activity, "Universe in Color".

Why do you think there are so few nebulae compared to stars?
Nebulae are scenes from either the birth or death of stars. These processes take relatively little time, compared to the lifetime a star. In fact, one of the ways astronomers can tell how long the stars live is by comparing the numbers of stars they see to the number of star births and star deaths they see.



GALAXIES

Does your galaxy image also contain stars in the field of view?
Most galaxy images should also contain stars in the field of view.

Which do you think is further away, the galaxy or the stars? Can you tell from your image?
Many students think the stars are further away, because they appear smaller. But all the stars we see with the telescope are in our own Milky Way galaxy. They are MUCH closer than the galaxies in your image. But you can't tell this just from looking at an image. A century ago, even the world's greatest astronomers were debating whether the galaxies were inside our own Milky Way, or were outside.

If the galaxies are further away than stars in our own galaxy, then why do they appear so large?
Each galaxy is an enormous collection of billions stars, as is our own Milky Way galaxy. It took additional information, beyond the actual images, for astronomers to conclude that galaxies are huge collections of stars.

Why can't I see the individual stars in the galaxies that I've imaged?
At the scale of your image, each individual star in the galaxy would be smaller than a single atom! It is truly amazing that the combined light of the stars can form the beautiful galaxy images you have created.

Why do the galaxies have such different shapes?
The shapes depend on how the galaxies were formed, whether they have collided with other galaxies in the past, and also on what angle you are viewing them from.

Are the galaxies all the same distance? If not, how far out do they go?
See the investigation, "In Search of Infinity."

When I look at a galaxy, am I looking at a place where other creatures live?
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