HOW DO TELESCOPES WORK?

ACTIVITY INSTRUCTIONS

http://www.ncsciencefestival.org/starparty

OBJECTIVES

- Discover that light spreads out with distance.
- Discover how telescopes collect and concentrate light.

SUGGESTED AGE RANGE

Ages 5 and up

ACTIVITY DURATION

5-7 minutes

SETTING

Indoors or outdoors

MATERIALS

- Paper plate
- Small flashlight
- 2 eye images
- Shaker-top container filled with "photons" (e.g., salt or black pepper)
- Foam strip with skewer sticks

PREPARATION

1. To prepare the foam and sticks, insert the sticks into the foam. You want the sticks as evenly spaced, vertical, and parallel as possible. Recommended: Glue the sticks into the holes.
2. Test your choice of material for the "photons" to make sure you can sprinkle them evenly across the plate.
3. Tape an eye image to the center of the paper plate. Have a second eye image ready for part 2 below.
4. Place the materials on a table.

BACKGROUND INFORMATION

Although other telescope characteristics, like magnification, are sometimes referred to as the telescope's "power," the most important power of a telescope is actually its ability to collect a lot of light, determined by the aperture (the diameter of the telescope's large lens or mirror). Telescopes can collect more light than our eye, and they can concentrate the light so it will fit into our eye, allowing our brain to detect the object.

PROCEDURE

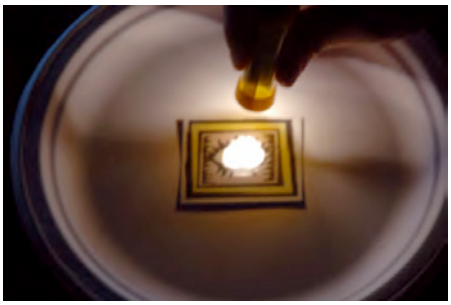
Part 1: Light spreads out with distance.

1. Say, "By the time light from the universe reaches Earth, the light is very dim. The farther the light-

PROCEDURE (CONTINUED)

emitting object is away from us, the dimmer its light appears to us here on Earth. Why?" (Wait for answers.)

2. Explain: "Light radiates. It spreads out as it leaves its source. Let's see what that means."
3. Hold the small flashlight very near the eye image taped to the paper plate.



4. Start very close to the eye, then move the light away to watch how the light spreads out and dims.

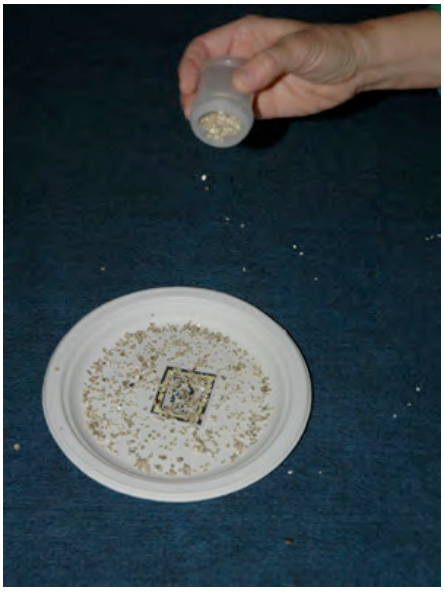
5. While you have the light held far away from the plate, indicate the pupil of the eye. Ask, "How much light is coming into the eye?" (Just that little amount.)
6. With the light still held at the same distance, indicate the entire circular plate representing a telescope mirror. Ask, "How much light is this plate collecting?" (A lot more.)
7. Ask, "If I took this light to (name something far away, e.g., that mountain top, the next city, the top of that building), would you still be able to see it?" (Probably not.)
8. Say, "Probably not. Less of the light would reach us, because it's spread out." You might make an analogy to water spraying out of a showerhead. The farther from the showerhead, the more the water is spread out.
9. Elaborate: "There is only so much light coming from an object every second. Packets of light are called photons."
10. Add: "A galaxy outside of the Milky Way is tremendously far away and its light is spread out all over the universe. So only a little of its light, or its photons, will hit the surface of the Earth. The more of its

PROCEDURE (CONTINUED)

photons we can collect, the more likely we are to see it. Telescopes have big mirrors to collect more of these photons."

Part 2: Telescopes collect and concentrate light.

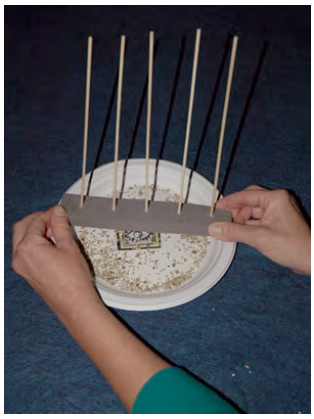
11. Indicate the plate with the eye image taped to it. Explain that the plate represents the size of a mirror in a telescope. Our eye needs at least 500 photons, or packets of light, coming into it every second for our brains to sense that something is there.
12. Indicate the "photons" in the shaker-top container. Explain that we'll use these to represent photons from a distant galaxy.
13. Indicate the plate. Explain that we'll sprinkle these photons for one second on this area (the plate).



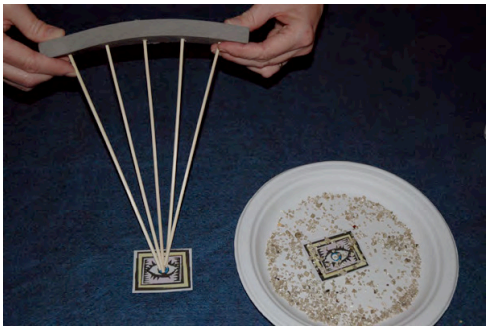
14. Sprinkle, or ask a participant to sprinkle, the "photons" evenly onto the plate for one second.
15. Point to the eye image on the plate. Ask, "Will our eye ever detect the light? How many photons are getting into the pupil of our eye?" (Just a few.)
16. Ask, "Is that enough light for our brains to detect it?" (No. We need 500 photons.)
17. Indicate the plate. "Is there enough light hitting the telescope mirror?" (Yes!)
18. Say, "But how can we get all that light hitting the telescope mirror into our eye?"

PROCEDURE (CONTINUED)

19. Hold the foam strip on the surface of plate. Explain that the foam strip represents a section of the telescope mirror. The sticks show the light from that galaxy reflecting off the telescope mirror.



20. Place a second eye image near the plate. Pick up the foam strip and bend it so that the sticks come to a point on the eye.



21. Explain that a telescope mirror is curved. So when the light comes in, the mirror reflects the light back to a point, like this.
22. Ask, “Now can we fit all this light into our eye?” (Yes!)
23. Explain that in essence, this is what a telescope does: It concentrates the light it collects into what is called a focal point (or focal plane). Using a second mirror, it redirects that light through an eyepiece and into our eye. That’s how we are able to see dim objects, like distant galaxies, using a telescope.

TIP

Hold the foam at either end, so that if you need to, you can use your fingers to position the sticks at the end.

MORE RESOURCES

Watch a video demo at https://www.youtube.com/watch?v=FLcjprQzfEk&t=196s (first 4 minutes). You can also find the video at http://www.youtube.com/user/NightSkyNetwork

CREDIT

We are grateful to the NASA Night Sky Network (https://nightsky.jpl.nasa.gov/) and the Astronomical Society of the Pacific for granting permission to modify materials they created.

NORTH CAROLINA SPACE GRANT

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