Space exploration starts with looking up at the sky, especially at night. The light that reaches your eyes can come from the Moon, the Sun, or any of the billions upon billions of distant stars.

Our star, the Sun, is like a light bulb or lamp. Light beams out from it in all directions at once. Think about this: the only light from any star—including the Sun—that gets to your eyes is the light that comes straight at you. Think of all the light and heat that’s beaming out—and already has been sent out—in all the directions other than straight at us, so we will never see it. It’s staggering. Most stars are billions upon billions of kilometers away, so we get to see only a tiny part of their light.

In astronomy, we study that precious bit of light that’s coming straight at us. But notice that your eyes gather light coming from many different directions. Light comes from your sides, from below your chin, from above your eyebrows, from nearby, and from far away.

**USE YOUR EYES TO LOOK AT YOUR EYES**

Go outside on a sunny day. Walk, bicycle, play ball, or just look at the sky (not directly at the Sun—that’s dangerous). Now, come inside, and as soon as you can, use your eyes to look at your eyes (that’s right) in a mirror.

You’ll notice that the black circle in the middle of each of your eyes is small—just a dot. Later, sit in the dark for a few minutes. You can try this at night or perhaps in a closet with a door that closes. After a minute or two, look in the mirror again. You’ll see that the black circle in the middle is pretty big around. The black circle, the pupil, closes or opens to let in just the right amount of light for your light receptors, the nerves in the back of your eyes. If your pupils are too wide open on a bright day, the excess light would damage your receptors. If your pupils are closed too far, you won’t be able to see much at all in dim light, like when it’s getting dark outside.

continued...
How does a telescope help us see light?

TELESCOPES ARE LIKE EYES—ONLY DIFFERENT
Telescopes gather and sense light just like your eyes do. But unlike your eyes, telescopes are seldom set up to sense light coming from any direction except straight at them. Because the light from stars comes from so fantastically far away, the only beams we see are going straight. Telescopes gather light and direct it into a smaller area, just like your eyes' pupils or a camera's lens.

BIGGER NET—MORE FISH; BIGGER TELESCOPE—MORE LIGHT
If you go fishing with a net, the bigger the net is, the more fish you can catch. Whether you're using telescopes, microscopes, binoculars, or your eyes, the wider they are open, the more light they'll catch. That's why observatories have big buildings—to hold big light-catchers (telescopes). The idea is to catch more light from distant stars, to see them better.

With a large telescope, light is gathered and directed into a light detector or image recorder. You put your eye to the eyepiece of a telescope, and worlds open up to you.

TELESCOPES ARE LIKE SPOONS FULL OF STARS
Telescopes must be set up like the bowl side of a spoon for them to work. Beams of light come straight into the telescope, no matter where in the sky it's pointed, because stars are so fantastically far away.

After a telescope has gathered light from a much bigger area than your eye, it must concentrate that light so that you can see the whole image with the small patch of your pupil or with a camera. The mirrors of the telescope must be shaped so that they bounce the light into this smaller area. The bigger the telescope, the more light it can gather, like a bigger fishing net. The telescope's mirror, or system of mirrors, must bounce the light to where it can be picked up by your eye or a camera and must concentrate it into this smaller area. As the light is reflected, its beams cross. Telescope images start out upside down and backwards.

TRY THIS
Get a metal spoon. Look at the back side—the side that rests on the tablecloth when you set the dishes and cutlery on a table. You'll see your face, but stretched into a funny version of you. Now, turn the spoon over, so that you're looking into the scoop or bowl side. Your face (or your friends' faces) will be upside down and distorted or bent up a bit, too. It looks like you're standing on your head (and holding a spoon).

To understand why this is, imagine beams of light bouncing off your face and down to the spoon. When the spoon's back side faces you, light bounces off your face, down to the spoon, and back again. When the spoon is bowl side up, the beams of light cross. The inward-curving surface of the spoon makes this happen.

Don't forget! Report back to us on your findings at planetary.org/kids
Large telescopes are often built on top of mountains, so that atmosphere and dirt don’t blur the image.

**Curved Mirrors Bounce Light, and Curved Lenses Bend It**

To gather the crossing beams and then spread them out to just fit your pupil, we use a lens that’s curved like the bowl side of a spoon. But instead of bouncing the light, the lens lets the light pass through and changes its direction a bit. You’ve seen this happen. When a mirror’s light-gathering is matched to a lens’s changes in direction, we say things are “in focus.”

**Try This!**

Here’s what you need:
- A few things to poke different-sized holes in paper—a pin, coffee stirrer, or pencil
- A box (this pullout will work as well—use the dotted lines to fold, and the solid gold lines to cut)
- A piece of waxed paper that will fit over one end of the box
- Tape to secure the waxed paper
- Scissors

1. Poke a hole in one end of the box with the pin, straw, or pencil. The less ragged you can make the edges of the hole, the better.
2. Open or cut off the other end of the box.
3. Tape the waxed paper over the open end.
4. Point the pinhole at a lamp.
5. You’ll see the image of the lamp on the waxed paper—only it will be upside down. The light beams must be crossing. Now notice that you can focus. There’s an old saying in science: we don’t see things; we see light bouncing off of things. You can move your camera viewer to change the size of the lamp.
6. Now, make the hole bigger.
7. You’ll see the image change a little. Hmm...

For the beams of light from the lamp that are headed your way to make it through the pinhole, they must come from the lamp and be headed through the hole so that they still hit the waxed paper. In Latin, a camera is a room or box. This type of box device is called a pinhole-camera-viewer. If there’s a digital image system or piece of film back there, we can take pictures.

**Don’t Have a Box? Try This**

Fold the paper of this insert along the dotted lines. Tape it together along the edges. Poke a pinhole at the green dot. Tape some waxed paper on the other end. Have a look around. Change the hole size a time or two and see what happens.
MERCURY

THE CLOSEST PLANET TO THE SUN
Mercury has the most elliptical orbit of all the planets.

DID YOU KNOW THAT ...

► Mercury is the smallest planet?
► Two of the moons in our solar system are bigger than Mercury? (They are Jupiter’s moon Ganymede and Saturn’s moon Titan.)
► We first sent a spacecraft past Mercury in 1974 and 1975? (That was Mariner 10, which also flew past Venus.)
► But we didn’t visit it again until MESSENGER flew past it in 2008? (MESSENGER has been orbiting Mercury since March 17, 2011.)
► Mercury rotates exactly three times for every two times it goes around the Sun?
► On Mercury, one solar day (from sunrise to sunrise) lasts 176 Earth days?
► But one Mercury year (one trip around the Sun) lasts only 88 Earth days? (That’s right—Mercury’s days are twice as long as its years!)
► Even though it’s the closest planet to the Sun, it doesn’t have the hottest surface? (Venus is hotter, thanks to the greenhouse effect.)
► Craters on Mercury are named for artists, musicians, painters, and authors from all over the world? (But they have to have died more than 50 years ago.)

At Mercury, the Sun feels 10 times as strong as it does at Earth. MESSENGER has a shiny sunshade to prevent it from overheating.

This vent doesn’t have a rim, like craters do, and it has a bright halo. MESSENGER scientists think this is probably a volcano that has covered the ground around it with ash.

Mercury: NASA/JHUAPL/CIW/Gordan Ugarkovic; crater: NASA/JHUAPL/CIW; MESSENGER in orbit: NASA/JHUAPL/CIW