

Turn your gaze skyward
and perhaps you'll see
across the cosmos.

How Far Can You See?

by PHIL PLAIT

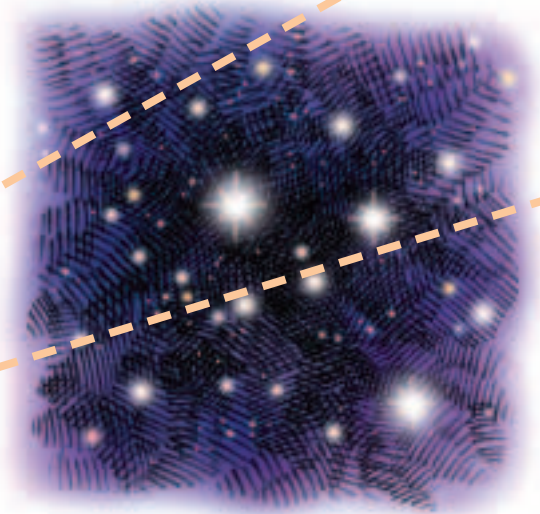
SOMETIMES WHEN YOU gaze at the sky, it may feel like you're looking out to infinity. It's natural to ask, "What's the farthest thing I can see?"

That turns out to be an interesting question! The universe is truly vast, and it's not as if there are highway signs reading "Next Rest Stop: 3 Million Miles" to help tell you how far objects are. But if you take a virtual journey to the farthest places the eye can see, you'll pass many amazing, unexpected, and surprisingly distant landmarks.

Most journeys begin during the day, so let's start there. What's the farthest thing you can see on a clear day? If you look around, your view is pretty limited. The horizon is only a few miles away. If you live near a mountain range, you might see a distant summit poking over the horizon 100 miles away.

But if you look skyward your gaze can stretch considerably farther.

If the Moon is up (yes, it can be seen during the day), then your view just went from 100 miles to about 238,000 miles! Not a bad hop. The Moon is the nearest astronomical object to Earth, yet it still took the Apollo astronauts three



days to journey there.

Keep looking around and you'll spot another astronomical object you can see during the day: the Sun. At an average distance of about 93 million miles, the Sun is about 400 times farther away than the Moon.

After the Sun sets, your sightline increases drastically. The farthest planet easily visible to the unaided eye is Saturn, which can be as far as a billion miles away. From a dark site, one can sometimes glimpse Uranus, and it's about twice as far as Saturn. It took more than eight years for the space probe Voyager 2 to reach that chilly planet.

Looking beyond our neighborhood, as far as we know, the nearest star to the Sun is Proxima Centauri, 4.2 light-years away. In other words, even traveling at the speed of

light, it would take more than four years to cross the 25-trillion-mile gulf separating us. And that's just to the *nearest* star!

Deneb, in the constellation Cygnus, is one of the brightest stars in the sky, yet it is roughly 2,300 light-years away. Eta Carinae, a fantastic powerhouse of a star in the southern constellation Carina, is beyond 7,000 light-years. When the light you see left that star, humans were just inventing metal tools.

While Eta Carinae is one of the most luminous stars in our galaxy and thus the probable limit for the farthest observable star, it's hardly the outer limit for our eyes. Galaxies are sometimes called "island universes" since they are vast collections of stars, gas, and dust. Our Milky Way is a good example, boasting hundreds of billions of stars in a spiral-spangled disk roughly 100,000 light-years across. The nearest such spiral galaxy to our own is the Andromeda Galaxy, which is about 2½ million light-years away. It is visible to the unaided eye as a faint smudge in the autumn sky (see page 30). It may not look like much, but consider this: when the light hitting your eye left the Andromeda Galaxy, the most intelligent creature on Earth was the ape man, *Australopithecus afarensis*.

Feeling small and dwarfed by these vast, cold voids? Just wait — your eyes can see farther still. In the 1960s astronomers discovered a new type of astronomical object. Called *gamma-ray bursts*, these turned out to be explosions of mind-numbing power. They come and go in literally the

blink of an eye — some last only 2 milliseconds (0.002 second) — yet for that brief moment these intense flashes actually outshine the Sun by a billion *billion* times!

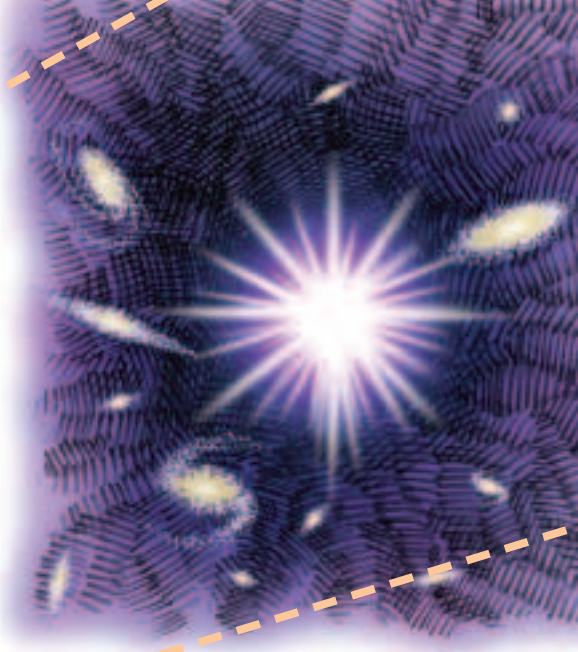
In January 1999 astronomers around the world got quite a shock when a burst almost reached naked-eye visibility. If you had been looking at the right spot with binoculars, you might have seen the event yourself! Still not impressed? Then consider that the burst turned out to be 9 billion light-years away. *That's more than halfway across the observable universe.* From that distance, even the Hubble Space Telescope couldn't see our Sun — our entire galaxy would be a dim smudge.

There's some evidence that gamma-ray bursts can and do get bright enough so that, looking with nothing more than your own eyes at the right place and the right time, you might be able to see light that has been traveling almost since the dawn of time itself.

Gamma-ray bursts don't happen often, and the odds are very low that you'd ever actually catch one, but it's possible. In fact, given enough time, someone will see one. And when that happens, it'll shatter any previous vision distance records.

The Nearest Star

Is Alpha Centauri really the nearest star? Nope — trick question! The Sun is. (That fooled me when I was younger.) However, Alpha Centauri — fabled in countless science-fiction stories — isn't exactly the next nearest star either. It's actually a triple system: three stars orbiting each other. The closest of the three, called Proxima Centauri, is a tiny, 4.2-light-year-distant red ember, visible only through telescopes. But it might not be the record holder either. It's possible that extremely dim stars called "brown dwarfs" lie undetected between Proxima and us. The technology for finding faint objects is rapidly improving, so if there is such a star, astronomers hope that they will find it in the next few years.



With that, our road trip across the cosmos is over. There's nothing bigger than the universe. From the nearby Moon to the forbiddingly remote realm of the gamma-ray bursts, our journey along the path of our vision stretches nearly as far as is physically possible.

So, on a clear day, can you really see forever?

Well, no. But on a clear night, you can come awfully close. ◀

Sonoma State University astronomer Phil Plait is webmaster and creator of Bad Astronomy (see page 97). The most distant object he has ever seen is the final payment on his home mortgage.

