



Ultra deep field image courtesy: S. Beckwith & the HUDF Working Group (STScI), HST, ESA, NASA

GOING Further

You can use this **4-STEP SCALE MODEL** to imagine some of the distances involved in NASA's explorations of the universe.

THE REALM OF THE EARTH AND MOON

NASA's three Great Observatories view the universe from their orbits near Earth: The Hubble Telescope orbits 550 km up from the Earth's surface. (2 mm at this scale) The Chandra X-ray Observatory orbits Earth as far as 1/3 the distance to the Moon. The Spitzer Infrared Telescope slowly drifts away from the Earth as it follows Earth's orbit around the Sun.

THE REALM OF OUR SUN

At this scale, the farthest distance humans have traveled is from the salt-grain Earth to the dust-speck Moon half an inch away. NASA is working to send astronauts to Mars, another 30 feet (10 meters) away at this scale.

THE REALM OF OUR SOLAR SYSTEM

What is the farthest distance a NASA spacecraft has traveled? Voyager I, launched in 1977, is now just beyond the Solar System, more than twice the distance to Pluto.

THE REALM OF GALAXIES

The most distant light captured by a NASA satellite has traveled through space for so long—more than 13 billion years—that it shows us a picture of the universe *before* there were any galaxies. The blotchy blue, green, and yellow colorized image from NASA's WMAP probe shows us what the glowing universe looked like shortly after the Big Bang.

REFLECTION QUESTIONS:

How likely do you think it is that there is life elsewhere in our galaxy? Intelligent life?

What challenges are there in trying to communicate with any potential life around other stars? In other galaxies?

Some people say they feel insignificant after understanding the scale of the universe; others say it makes them feel that life on Earth is special; still others feel amazement at the power of the human mind. *What's your view?*

The Universe Education Forum is a national center for teaching and learning about the structure and evolution of the universe. Sponsored by NASA and based at the Harvard-Smithsonian Center for Astrophysics, the Forum uses the unique resources of NASA's space science research program to create exciting learning experiences for students, teachers and the public.

To explore more, visit: www.nasa.gov



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THE INCREDIBLE TWO-INCH UNIVERSE

2IN

A NASA-Smithsonian Universe Forum Publication

SIZE AND SCALE OF THE COSMOS IN JUST 4 STEPS

The realm of the **EARTH AND MOON**

The realm of **OUR SUN**

The realm of **OUR SOLAR SYSTEM AND NEARBY STARS**

The realm of **GALAXIES**

Plus other great explorations!



WRAP YOUR MIND AROUND THE VAST DISTANCES IN THE UNIVERSE!

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WHAT YOU'LL NEED
A MEASURING TAPE
6 ROUND IMAGES FROM INCREDIBLE TWO-INCH UNIVERSE CARD
A GRAIN OF SALT
A WIDE OPEN MIND

WHAT TO DO:

Explore the universe by shrinking cosmic scale in 4 steps, zooming out from the realm of the Earth and Moon to the realm of the galaxies. At each step, hold up the image that represents that cosmic object scaled down to 2 inches (about 5 cm) in diameter. Ask a friend to predict the scaled sizes and distances of the objects listed below before you reveal the answer.

Step 1: The realm of the EARTH AND MOON

If you shrink the Earth to about 2 inches (5 cm) in diameter, here's how other objects would compare in size and distance*:

MOON SIZE	1/2 inch (1.3 cm) – hold Earth and Moon images, one in each hand
EARTH-MOON DISTANCE	5 feet (150 cm) – spread your arms wide to hold images 5 feet apart
SUN SIZE	16 feet across (5 m) – imagine a yellow ball the size of a minivan
EARTH-SUN DISTANCE	1800 feet (550 m) – about 6 soccer fields apart
LIGHT TRAVEL TIME	Light travels through space at a constant speed of 186,000 miles per second (300,000 km/sec). At this scale, where the Earth is 2 inches across, we've shrunk 186,000 miles down to about 4 feet. It takes a beam of light a little more than one second to travel from the Moon to the Earth.

Step 2: The realm of OUR SUN THE ONLY STAR IN OUR SOLAR SYSTEM

Now let's switch scales by shrinking the minivan-sized Sun down to a 2-inch diameter.

EARTH SIZE	A grain of salt, with a dust-speck Moon 1/2 inch away from it
SUN-EARTH DISTANCE	20 feet (5.5 m) – or 10 paces away
PLUTO'S ORBIT	2.5 soccer fields away from the 2-inch Sun
NEAREST STAR TO SUN	900 miles away (1500 km)
LIGHT TRAVEL TIME	It takes 8 minutes for a beam of light to travel from the Sun to the Earth.

Step 3: The realm of OUR SOLAR SYSTEM AND NEARBY STARS

Now let's shrink the entire Solar System down to 2 inches in diameter: (Planet sizes and orbits on 2-inch image are NOT to scale!)

SIZE OF SUN	Microscopic at this scale, a shining speck at the center of the image
SUN-EARTH DISTANCE	1/2 mm – Earth orbits very close to the center of the Solar System
PLUTO'S ORBIT	Around the edge of the 2-inch Solar System image
NEAREST STAR TO SUN	2 soccer fields away
NEARBY STAR DISCOVERED TO HAVE ORBITING PLANETS	5 soccer fields away. Two planets have been discovered around the star Epsilon Eridani, which is visible from the southern hemisphere.
OUR MILKY WAY GALAXY	Size of North America. At this scale, our 2-inch Solar System is part of a continent-sized system of 200 billion shining speck stars. These stars, spread 30 miles (50 km) high, are generally separated from each other by more than 2 soccer fields.
LIGHT TRAVEL TIME	It takes about 10 hours for a beam of light to cross the Solar System and years for light to travel between stars.

Step 4: The realm of GALAXIES

Now let's switch scales one last time, and shrink the entire continent-sized galaxy down to 2 inches:

SIZE OF SUN AND STARS	Individual stars are invisible, smaller than atoms, at this 2-inch scale. The bright specks in this galaxy image come from the added light of thousands of stars.
LOCATION OF SUN	1/2 inch (about 1 cm) from edge of 2-inch galaxy image
DISTANCE TO ANDROMEDA GALAXY, THE NEAREST SPIRAL	5 feet (1.5 m) at this scale – hold the two galaxy images apart with your arms spread wide.
DISTANCE TO FARTHEST GALAXIES OBSERVED BY HUBBLE TELESCOPE	4 miles (6.5 km). In the Hubble image of the "Ultra Deep Field" almost all the fuzzy spots of light are distant galaxies. Because light takes time to travel through space, we see the farthest of these not as they are now, but as they were 12 billion years ago.
SIZE OF THE WHOLE UNIVERSE?	No one knows... it could be infinite.
LIGHT TRAVEL TIME	It would take 100,000 years for a beam of light to cross our galaxy and 2.5 million years for light to travel from the Andromeda Galaxy to us.

*Distances in this activity are approximate, in order to give you a rough feel for astronomical scale.



THE SUN

Credit: NASA

To find out more about the Sun, visit: <http://sunearth.gsfc.nasa.gov>

THE EARTH

Credit: NASA

To find out more about the Earth and Moon, visit: <http://earthobservatory.nasa.gov>

THE MOON

Credit: microobservatory.org

ARTIST'S ILLUSTRATION OF THE MILKY WAY

Credit: NASA/JPL-Caltech/R. Hurt (SSC)

To find out more about galaxies, visit: <http://amazing-space.stsci.edu>

THE SOLAR SYSTEM

Credit: NASA/SAO

To find out about planetary systems being discovered around other stars, visit: <http://planetquest.jpl.nasa.gov>

ANDROMEDA GALAXY

Credit: Palomar Observatory, P. Challis, CfA

To find out about black holes in the Andromeda Galaxy, visit: <http://chandra.harvard.edu>