How big is our Earth in proportion to the rest of our Solar System?

The size of the Earth, its artificial satellites, and the Moon is so enormous it's hard to grasp. Most of us will never circle the Earth, and for those who do, it's still difficult to incorporate the massive scale in our thinking. For me, comparing distances having more than five digits is mind-numbing.

A couple of years ago I wrote an article about the scale of the sizes and distances of our man-made satellites and the Moon, using a 3-1/8" *(8 cm)* clementine or tangerine as Earth and, about eight feet *(2.5 meters)* away from it, a three-quarter-inch *(19mm)* grape as our Moon.

The article concluded with a link to a fun video some people had made, demonstrating the scale of the planets in our solar system. That video's no longer on the internet, so let's continue with the scale of the tangerine-size Earth and the grape-size Moon and see the relative scale of the rest of the solar system.

On the International Space Station, are they at risk of hitting one of the satellites we use for phone links and GPS?

Let's talk about the earth using a scale we can all understand.

Imagine a sphere 3-1/8" (8cm) in diameter. A bit smaller than a baseball; a large clementine. We'll measure the distance around this sphere (its circumference) by sticking a long piece of tape around its "equator," cutting it off so it doesn't overlap. Now imagine pulling the tape off and using its length to measure a distance from the earth (the clementine). Your tape will be 10" (25 cm) long.

The distance around the earth is 25,000 miles and the distance those geostationary satellites have to be from the earth is about this same distance (22,236 mi.) in order for their orbits to match the speed of the earth's rotation to stay directly above the same place on the equator. So in our scale model, imagine a thin ring above the "equator" of your clementine suspended the length of your tape (10") away from the clementine, like a two-foot diameter thin wire halo floating around your clementine.

This demonstrates the scale of the earth in relation to the orbits of those satellites. At this small scale, the geostationary satellites around our clementine would be so small they'd be invisible, just as you wouldn't be able to discern a cruise ship on our clementine-size earth.

Now imagine measuring that 10" (25cm) with a ruler. The International Space Station's orbit is only 248 miles above the earth. That's about one ***hundredth*** of the distance to the orbits of those geostationary satellites, one tenth of an inch (2.5mm) above the skin of the clementine. The ISS orbit is tilted in relation to the earth unlike satellites on equatorial orbits. The space station is going 17,150 miles per hour, completing an orbit every hour and a half, 16 times per day.

Well, that's pretty low! Why doesn't the ISS need to be streamlined like a plane, to deflect the wind?

The air around the earth (the troposphere) is only about 9 miles deep. The passenger planes you use for vacations fly at about 35,000 feet. That's about 6-1/2 miles up. At 248 miles, the ISS doesn't encounter any air.

Since those geostationary satellites are so very far out there (your 10 inches from the clementine) how far away from the earth is the ***moon****?*

The moon is about ***ten times*** as far from the earth as those satellites! (238,855 mi.) So in our clementine scale model, a hundred inches (2.5 meters)! Eight feet four inches. (The ceiling in an average bedroom is eight feet above the floor.)

The moon is about 1/4 the size of the earth, so about 3/4 of an inch (a large, spherical grape) way out there over eight feet from the clementine.

OK, on this scale model, now that we have the earth and the moon, where's the sun? How far away and how big is it compared to our clementine and our grape that's eight feet away?

This is going to be harder to visualize. If you're a football fan, it might help. If you were in the stands in a football stadium or watching the game on TV, you wouldn't be able to even SEE our clementine down there on the field. Let's put our clementine outside one end zone. Beyond the far end zone is a huge sphere, over a hundred times the size of the clementine, the size of a two-story house, 28 feet tall. That's the sun. It takes light 8 minutes and 20 seconds to reach the earth from the sun. Light reflected from the moon takes one and a third seconds to reach the earth. Here's the scale of the solar system: https://youtu.be/Kj4524AAZdE

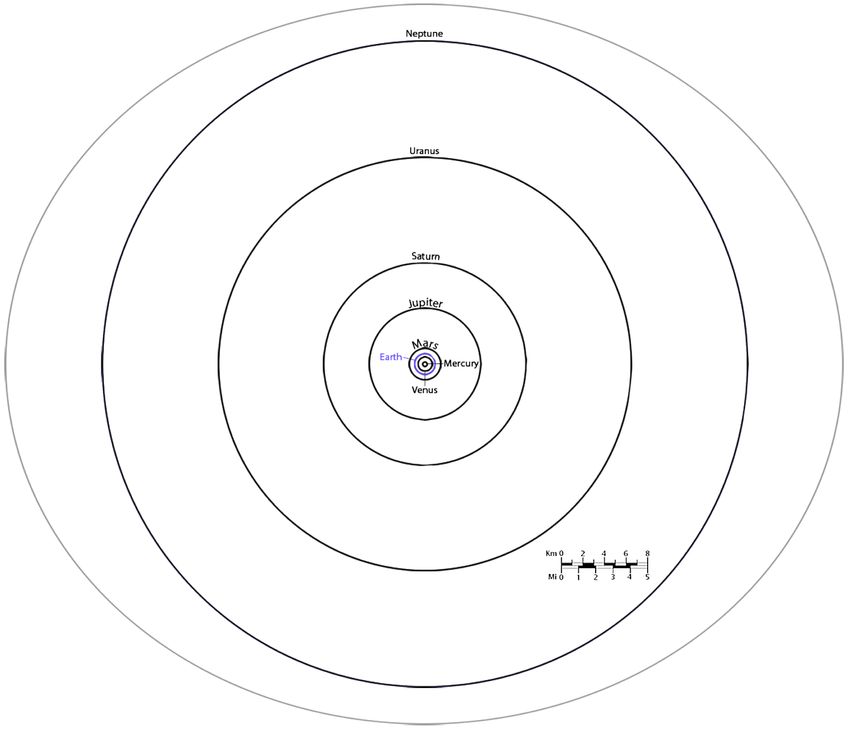
—12/02/20 Bruce Philpott

Of course, that Moon doesn't just sit eight feet away, it circles the tangerine, completing the circle every 27 days as Earth makes its year-long circuit around the Sun, which at this scale is about five-eighths of a mile *(1 km)* from the tangerine Earth. The Sun would be a 28-ft. *(8.5 meter)* sphere; the only significant source of light and heat.

At some time or other, you've been shown a diagram of the planets all lined up in order outward from the sun. They're really never aligned like that, but it makes it easier for them all to fit in order on the diagram on the page. In reality, they're each in motion someplace in their concentric orbits around the Sun and far too small to be seen on a diagram which includes the sizes of their orbits. Our scale model of Earth is a tangerine on a circular path that's a mile and a quarter *(2 km)* in diameter; not something easily illustrated. On any particular day, the planets might be spread out in every direction from the Sun like the numbers on an analog clock.

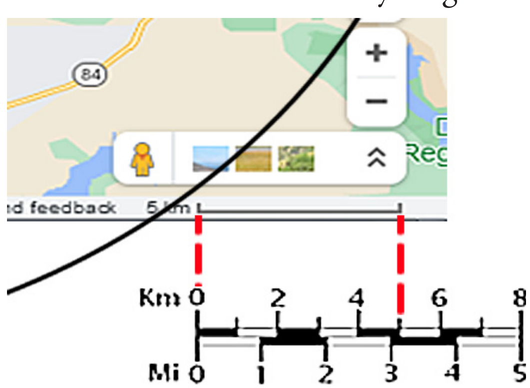
By the way, you could take all of the planets and fit them between Earth and the Moon! Really! Well, you couldn't move them there, but if you could, they'd fit, just barely, with the Moon at its greatest distance from Earth. The planets are smaller than you thought and the Moon's elliptical orbit is further from Earth than you might realize, too.

Instead of trying to figure out how far one kilometer is in order to understand our scale, you can



download my [free transparent .png diagram of our solar system]() and then make a screen capture of a Google map of your locale with a scale of miles/kilometers on it (it'll be small, in the lower right corner), and combine them on your computer, if you have one.

If you have Photoshop (or GIMP, a free download), drag my transparent diagram onto your map and adjust the sizes of those layers until the scales are the same: so five kilometers on my diagram equals five kilometers on your map, as shown below. Now, tangerine in hand, you have an idea of the scale of the solar system. See that landmark 18 miles *(30 km)* away? That represents the distance of the orbit (all the way around you) of Neptune.



Out in space, of course, there are no landmarks like the ones mentioned on the next two pages or like those on your own map. It's more like an infinitely large, black, un-striped parking lot covering all that acreage you're looking at. Naturally those orbit lines aren't visible either, so Earth is just a blue tangerine-size ball here, and about two and a half miles over there is Jupiter, the size of a large exercise ball (no, you couldn't see it from here).

Mercury's the size of a large strawberry and it's half a mile or more away, maybe in the other direction. Mars is the size of a golf ball over a mile away in yet another direction. Half of the eight planets are smaller than Earth (our tangerine) and the other half (miles away at this scale) are under three feet ***(1 meter)*** in diameter. There's a lot of space in space; that's why they call it space.

If these orbit circles were bike/walking paths, Mercury's large strawberry could be easily carried around its 1.5 mile ***(2.38 km)*** circumference. It would be difficult to bike Saturn's large exercise ball around that 35 miles ***(56 km)*** of track. (On second thought, those huge rings would make it too cumbersome). I know one avid cyclist who could carry Neptune's 12-1/8" ***(31 cm)*** sphere on his bike the entire hundred and eleven miles ***(179 km)*** of that circle. These people would be several miles away from each other, of course.

Notice on my accurate scale that the orbits of Mars, Earth, Venus, and Mercury cluster closely together in the center. It's no wonder early astronomers had the impression the (outer) planets were orbiting Earth, because they're orbiting this cluster that includes the Sun and Earth.

You may be wondering how far away other solar systems are from us in this reduced, hopefully more relatable scale. Our nearest star system is Alpha Centauri which is a cluster of three stars and their planets. That system is twenty-five trillion (25 with 12 zeros after it)

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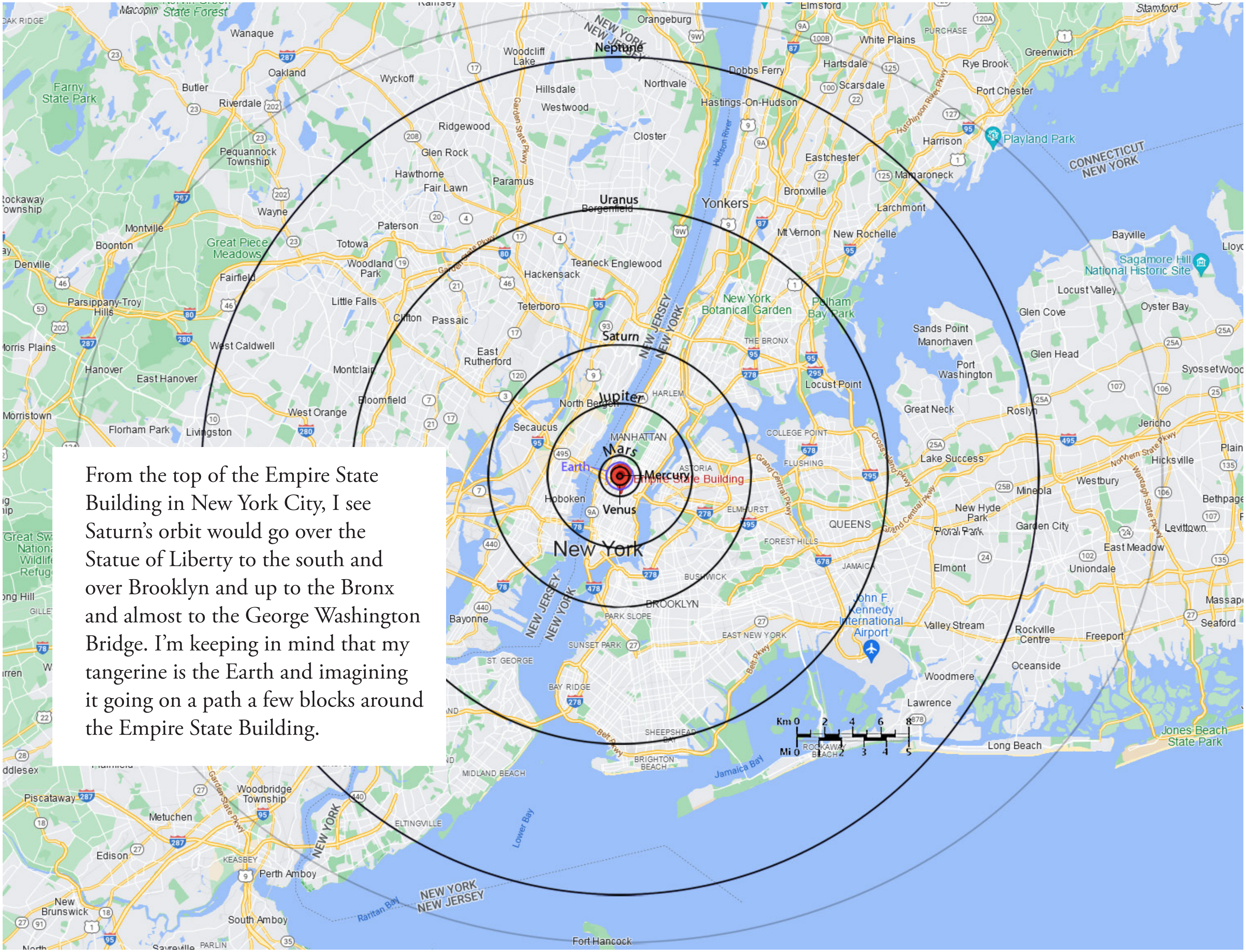
From Twin Peaks in San Francisco, with my tangerine in my pocket and imagining that 3/4" grape slowly circling me at an eight-foot radius, I can see Jupiter's orbit takes up almost the entire tip of the San Francisco peninsula, while Uranus' path goes below San Francisco International airport, beyond Oakland and up over the Richmond-San Rafael Bridge.



From the top of the Empire State Building in New York City, I see Saturn's orbit would go over the Statue of Liberty to the south and over Brooklyn and up to the Bronx and almost to the George Washington Bridge. I'm keeping in mind that my tangerine is the Earth and imagining it going on a path a few blocks around the Empire State Building.

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miles *(over 40 trillion km)* away. It takes light four and a third years to reach us from there. To understand this enormous distance on our to-scale map, where the tangerine is Earth and Neptune's orbit is 18 miles *(30 km)* away, the distance to our real Moon would represent the scale distance to Alpha Centauri. Space!

The gray elliptical outer line on the transparency represents Pluto's orbital path. Pluto is only two-thirds the size of our Moon and its very elliptical orbit is tilted 17 degrees from plane of the orbits of the actual planets. I'm amazed we've known about that distant dwarf planet for so many centuries.

Most of the planets rotate on their axis somewhat similar to Earth as they orbit the Sun, but there are a couple of interesting exceptions.

At first glance, Venus seems not to rotate on its axis at all, but when astronomers studied it over time, it was observed to rotate incredibly slowly in the opposite direction of the other planets, so it has a day slightly longer than its year, with the Sun rising extremely slowly in the west.

Uranus is a strange one, too, in that its axis is tilted sideways, in line with its orbital direction. It's thought that these anomalies were caused by impacts of passing planets.
https://youtu.be/qhJrpzsKEXo

A silly school kids' mnemonic for the order of the planets in the solar system (from the Sun) is "My Very Educated Mother Just Serves Us Noodles." I found myself reciting it when writing this article.

Planet	**Distance from Sun**	**Scale dist. from Sun**	**Actual Diameter**	**Scale Diameter**
Mercury	36 mil. mi. *57.9 mil. km*	1/4 mile *.39 km*	1,516 mi. *2,440 km*	1-1/8" *3 cm*
Venus	67 mil.mi. *108 mil. km*	1/2 mile *.72 km*	3,750 mi. *6052 km*	3" *7.6 cm*
Earth	93 mil. mi. *149.6 mil. km*	5/8 mile *1 km*	3,959 mi. *6,371 km*	3-1/8" *8 cm*
Mars	142 mil. mi. *228 mil. km*	1 mile *1.5 km*	2,106 mi. *3,390 km*	1-2/3" *4.26 cm*
Jupiter	484 mil. mi. *778.3 mil. km*	3-1/4 mi. *5.2 km*	43,441 mi. *69,911 km*	35" *89 cm*
Saturn	887 mil. mi. *1,427 mil. km*	6 miles *9.5 km*	36,184 mi. *58,232 km*	29-1/2" *75.68 cm*
Uranus	1,790 mil. mi. *2,871 mil. km*	12 miles *19.2 km*	15,759 mi. *25,262 km*	12-5/8" *32cm*
Neptune	3,670 mil. mi. *5,906 mil. km*	18-3/4 mi. *30.1 km*	15,299 mi. *24,622 km*	12-1/8" *31 cm*

Scale: 1:150,000,000

One AU (Astronomical Unit) actual size = 150,000,000 km = 1 km in our model

Here's a newer version of that terrific seven-minute video I had linked to in my first article: https://youtu.be/zR3Igc3Rhfg

You'll find more of my articles and tutorials at brucephilpott.com/tutorials