



## WHAT IN THE WORLD IS AN ORRERY

by Ken Durmmnd

An Orrery is a model of the Solar System, usually constructed as a clockwork mechanism that sits on a desktop. A large, outdoor “human” Orrery is located just a few hundred yards before the north entrance to Joshua Tree National Park at SKY’S THE LIMIT Observatory and Nature Center in Twentynine Palms, California. This Orrery is visible from space! Zoom in with Google Earth and you will see it.

This is called a “human” Orrery because live participants demonstrate the scale of the Solar System and the motion of the planets as they revolve around the Sun. By walking out the motions of the planets, participants see first-hand how the Solar System operates.



*Photo 1: This is an Orrery, which is a model of the solar system named after the Earl of Orrery. A small orrery was presented to Charles Boyle, the fourth Earl of Orrery, in 1704 and the name Orrery stuck. This is our version and, as far as we know, it is the only true-to-scale, true-to-position Orrery in the world. Our scale is 20 billion to one, which means the real sun is 20 billion times bigger than ours.*

### THE HUMAN ORRERY STORY

The Orrery began as a simple way to visualize the planets. The first task was to place rocks on the ground to represent the planets and their distance from each other. The first four planets were relatively close to one another, but the next four required a certain amount of hiking in order to visit them.



## 20 BILLION TO ONE

The next step was to place the planets in the proper places in their orbits. The JPL NASA Horizons website will calculate the positions of the planets for any time or date. Using this data, we wrote some simple computer programs to calculate the distances to the planets-at a greatly reduced scale. The scale we used was 20 billion to one. In other words, the planets in the Orrery are 1/20 billionth the size and distance of the real planets.

## STEPPING OUT THE ORBITS

The orbits of the inner planets are marked out using steppingstones. Each steppingstone represents four days of travel around a planet's orbit. Several people can "impersonate" planets and walk around the orbits counting the stones at the same speed. You will notice that Mercury's orbit is completed very quickly, but it takes much longer for Earth and Mars to complete a trip around the Sun.

The planes of the orbits are inclined or slanted. Each planet's orbital plane is inclined a different amount, relative to Earth's orbital plane. When you go around Mercury's orbit, for example, you will be walking up and down a small hill over and over. This feature of the Orrery demonstrates the actual angle of the planets' orbital planes, and is unique among orreries, as far as we know.



*Photo 2: Young learner walking the Solar System, 4 Days each step following Mars path around the Sun.*

The planet markers show the current positions of the planets. All the planets move around their orbits in a counterclockwise direction. If you are only familiar with digital clocks, "counterclockwise" means that when you are standing facing the Sun you walk to your right.

## ORRERY HISTORY

The word Orrery comes from a solar system model that was made around the year 1700 and presented to Charles Boyle in England. His title was The Fourth Earl of Orrery. So after that time, models of the solar system became associated with his name and were called orreries.

## TRUE SCALE & POSITION

We call this Orrery a True Scale and Position (TSP) Orrery. Since the Sky's The Limit Orrery is true to scale, everything is the same size, relatively speaking, as the real Solar System. For instance, when you stand at the Earth marker and look at the model of the Sun, in the middle of the Orrery, then look up at the real Sun (with appropriate eye protection), you will see that they appear to be the same size. They are not the same size of course, but they appear to be.

Likewise, if you have a telescope and aim it across the parking lot at the model of Jupiter, then, if it is nighttime, aim your telescope at the sky-you will see that both Jupiters, real and representative, appear to be the same size.



All the Orrery distances are proportionally correct, including the slopes of the planets' orbits – well, for the four inner planets anyway. It would have been too difficult to landscape the ground to get the correct inclinations for the outer planets, but the natural slope of the land comes close.

### **PLANETS FAR AWAY...**

We use moveable markers to represent the planets' positions. The planets themselves are very tiny at the scale we use. The sun is less than three inches in diameter. The four inner planets-Mercury, Venus, Earth, and Mars-are represented by ceramic orbs within the hundred-foot radius of the main Orrery circle. To understand the size of each planet relative to the Sun, feel the very tiny projection on top of the ceramic sphere: that's how small it is at 20 billion to one! The other planets lie way beyond the driveway. Jupiter and Saturn are on Sky's The Limit property, but Uranus and Neptune are off in the distance. Pluto is off in the direction of the mountain, and Eris, one of Pluto's fellow dwarf planets, is about half a mile away.

### **DWARF PLANETS, COMETS & ARTISTS**

Around the perimeter of the Orrery Circle there are a number of large blue pedestals. On these are information and arrows pointing in the direction of the outer planets, dwarf planets, and asteroids. We also track comets as they travel through the Orrery.

### **OUR ORRERY**

Morongo Basin artists contributed their talents to make the Orrery beautiful as well as educational. Sky's The Limit is very grateful to sculptor Steve Rieman and ceramic artist Ed Keesling for conceptualizing and creating the planet markers, and to Steve Rieman and Bruce Jones for fabricating the information pedestals.

We hope you will enjoy your experience at Sky's The Limit Orrery. Think of yourself as a cosmic giant walking around the solar system. You are able to view everything from various angles.



*Photo 3: Orrery being built.*

### **INFORMATION ABOUT THE ORRERY**

Scale: 20 billion to one

Type: Combined TSP (True Scale & Position) & Human Orrery

Conception & Original Planning: 2004-2005 by Peter Bertain

Current Plan and Construction: 2009 -2011 by Ken Drummond and volunteers

Planet markers created by sculptor Steve Rieman and ceramic artist Ed Keesling

Perimeter pedestals created by Steve Rieman and Bruce Jones



#### Features:

- All orbits and planets are true to scale.
- Inclinations of Orbits are shown for inner planets.
- Planets and Moon move around their orbits (accurate within 4 to 8 days).
- Visitors can pace out the orbits of the planets on the steppingstones. Each steppingstone represents 4-days of travel (for the inner planets).
- Pedestals along the Orrery's perimeter point to the outer planets, dwarf planets, some asteroids, and current prominent comets.
- Weekly Saturday morning talks give additional information about the Orrery, the Solar System, and other subjects related to astronomy.

#### THE STEPPINGSTONES

The circles of steppingstones are the orbits of Mercury, Venus, Earth, and Mars and each stone represents 4 days of travel for the planet. All of the planets move in a counterclockwise direction around its orbit. We come out every week and move the planets to the correct position, so it is true as of the last Saturday someone was here.



#### HOW MERCURY ORBITS THE SUN

You may have noticed that the sun is not in the center of the orbit of Mercury. It is offset, making the orbit an ellipse. All the planets' orbits are ellipses, but Mercury's is most obvious. Note that the stones at the top of the orbit are farther apart than at the bottom. This is because as Mercury gets closer to the sun it moves faster so the stones must be farther apart to represent four days of travel. As the planet falls toward the bottom it slows down so four days is a shorter distance.

#### WHAT DO ORBS REPRESENT?

The orbs represent the planet's position, and they are not scaled to their actual size. The actual size of the planet is the little nub on the top of each orb. The size of Earth's nub is 0.6mm, Venus and Mars are 0.5mm, and Mercury is 0.3mm. The distance from the Earth nub to the sun is the 93 million miles we all learned about in science class, at the 20 billion to one scale. For a sense of size imagine us walking around on the small Earth nub. The moon orbits this 0.6mm Earth about  $\frac{3}{4}$  of an inch away.





### THE ASTEROID BELT

Check out the driveway. The driveway represents the Asteroid Belt, millions upon millions of asteroids in the belt. The two steppingstones in the asteroid belt, one to the Northwest of the Sun represents Vesta, and the one to the North of the Sun represents Ceres, the two largest objects in the belt. In September 2007 a probe was sent to Vesta, which arrived and put a satellite into orbit in July of 2011. It has since left Vesta and headed toward Ceres. It arrived at Ceres in September of 2015 and has taken up an orbit around Ceres. If it completes this maneuver, it will be the first spacecraft to visit Ceres and the first time a man-made object will have orbited one body in space, left that orbit, and taken up orbit around another body in space, except for moon/earth orbiting.



### JUPITER, SATURN, URANUS & ERIS

Look around the Orrery outside the asteroid belt and locate the red and orange flags. They represent the positions of Jupiter (red flag) and Saturn (yellow flag). Uranus is 163 yards to the North, represented by a stack of rocks approximately three feet high; Neptune is 244 yards behind the first metal sculpture, a second stack of stones; and Pluto is 270 yards to the East, a small third stack of rocks. Since Pluto is no longer a planet a new body has been nominated for 9th planet status and that is Eris, located 770 yards in the direction of the left-hand building, the Visitor Center, and is represented by a stack of rocks about 3 feet tall. Uranus, Neptune, and Eris are off our property which is why there are no flags.





### VOYAGER I

Two other items of interest are Voyager 1, launched in September 1977, which in August 2012 left the solar system and entered galactic space. It is at 255 degrees, on the Sun table, approximately 1100 yards out, at the 20 billion-to-one scale. No marker yet.

The other is our sun's nearest neighbor, Alpha Centauri. It is 4.5 light-years away, at the 20 billion to one scale, which puts it about 100 miles North and 30 miles East of Mexico

City. No marker yet, if anyone is planning on going there let us know and we will give you a set of GPS coordinates so you can poke a stick into the ground and take a picture for us.

