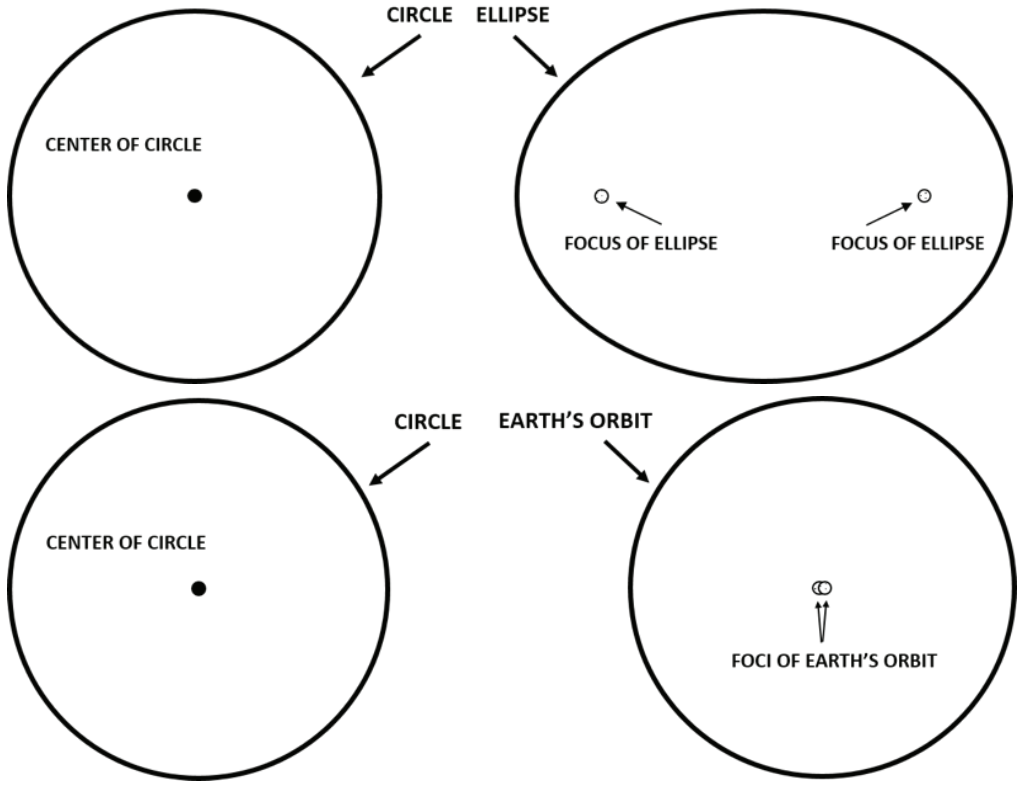
What's Up?

BY BARRY DECRISTOFANO

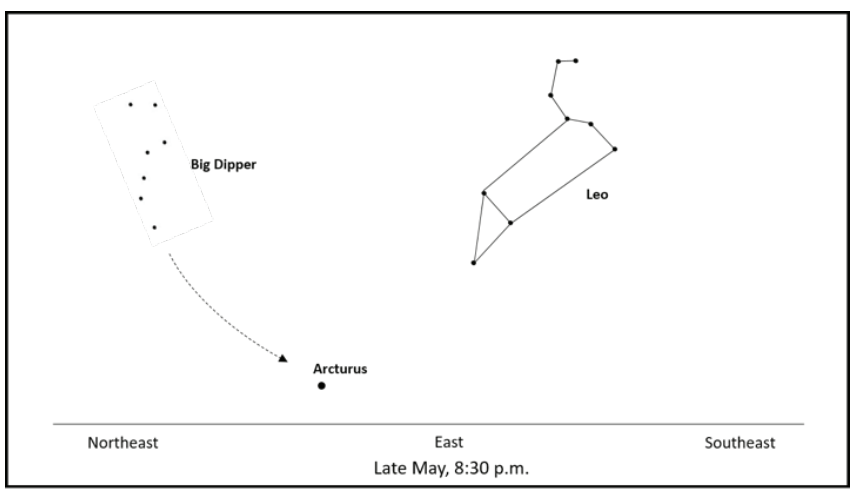
Hi. In the last *What's Up?* we took a historical trip to look at the different models that have been used to describe the motions of the Sun, Moon, and planets, leaving off with Johannes Kepler and the three laws of planetary motion. While the words I used described the laws, a picture is worth a thousand words. Let's start with the First Law of Planetary Motion – the planets move in elliptical orbits, with the Sun at one of the foci. Just in case you've forgotten your geometry (or haven't taken it yet), we'll start with the difference between an ellipse and a circle. They are both closed curved lines – that is, their ends meet each other. A circle has a special point associated with it. It is the point that at the center of the circle. An ellipse has two special points called *foci*. Foci is just the plural form of the word focus. All of the points along the curve of a circle have a special property. They are all the same distance from the center. All of the points along the curve of an ellipse also have a special property. The sum of a point's distance to each of the foci is a constant.



The further apart the foci are, the longer and skinnier the ellipse is. Ellipses are classified by how long and skinny they are. The term is called the *eccentricity*. Ranging from 0 to 1, the eccentricity tells us whether an ellipse is long and skinny or more like a circle. In fact, a circle is just an ellipse with an eccentricity equal to 0 (an ellipse whose foci are at the same point). The ellipse above has an eccentricity value of 0.66. Now, with this bit of geometry under our belts, let's look at the difference between a circle and the Earth's orbit.

Notice the difference? It's pretty small, isn't it? The foci of the Earth's orbit are relatively close together. In fact, the eccentricity of the Earth's orbit is 0.017 (and remember, an eccentricity of 0 is a perfect circle). The Sun is located at one of the focus points. So why all the fuss about whether the planets move in circles or ellipses? Over the vast distances that we deal with in our solar system, a small difference in the distance between foci near the middle of a planet's orbit results in an error in a planet's position in our sky when we think the planet travels in a circular orbit and it really doesn't. The more precise our measurements became (and Tycho Brahe's measurements were the most precise of all up to that point), the clearer it was that circles weren't really how orbits were shaped. Kepler wanted to study Tycho's data on the positions of Mars to figure out the correct motion. After about four years of calculating and re-calculating, he worked it out. The orbit was an ellipse. An elliptical orbit explained all of the apparent motions of Mars in our sky without needing to resort to any epicycles, equants, or anything else. Just an ellipse. Applying this shape to the other planets' orbits, also matched all of the available data. He was sure that this was how planets moved around the Sun. Note that I said "all of the available data". Over time it was clear that there was a problem with matching the First Law with Mercury's orbit. It took Einstein's theory of general relativity to supply the tweak to the Newtonian model of gravity that was needed to fully explain Mercury's orbit. One note is that some folks, having learned in school that we have different seasons during the year is because the Earth's orbit is an ellipse. That is not the reason. The seasonal changes we experience are due to the Earth's axis being at an angle with respect to our orbital plane. I'll look at Kepler's 2nd and 3rd Laws next time.

Moving on for now, here's what's up.



In the evening sky, starting in the Northeast, you can find the Big Dipper standing on its handle. The handle still (as always) 'arcs towards Arcturus', now down low on the horizon after sunset. Turing to your right a bit so that you are looking towards the East, you can see Leo the Lion about half-way up in the sky. The lion is headed up in the sky and will be with us all Summer. In the West, you can still find Venus. Over the coming week it is being joined by the Moon as the Moon makes it way along the ecliptic.

In the morning sky, the parade of the outer planets Mars, Jupiter, and Saturn now forms a bit tighter group than before, with the three located in a space just over ½ of your fist's width when your fist is held out in front of you at arm's length. Mars is pretty much smack dab in the middle of the three, with Saturn the closest to the horizon. In comparison to the sky at sunset, described above, the Big Dipper is about horizontal in the NW, and yes you guessed it, its handle is arcing towards Arcturus which is about ½-way up from the horizon in the West.

Keep on tracking these movements of the stars and the planets and get to have a feel for yourself of the gravity-driven motion of the Earth, Moon, and planets. I really believe that it will enhance your appreciation of our night sky.

You can reach me at astroblog@comcast.net. This is *What's Up?* Installment #16.

Keep looking up!

Barry