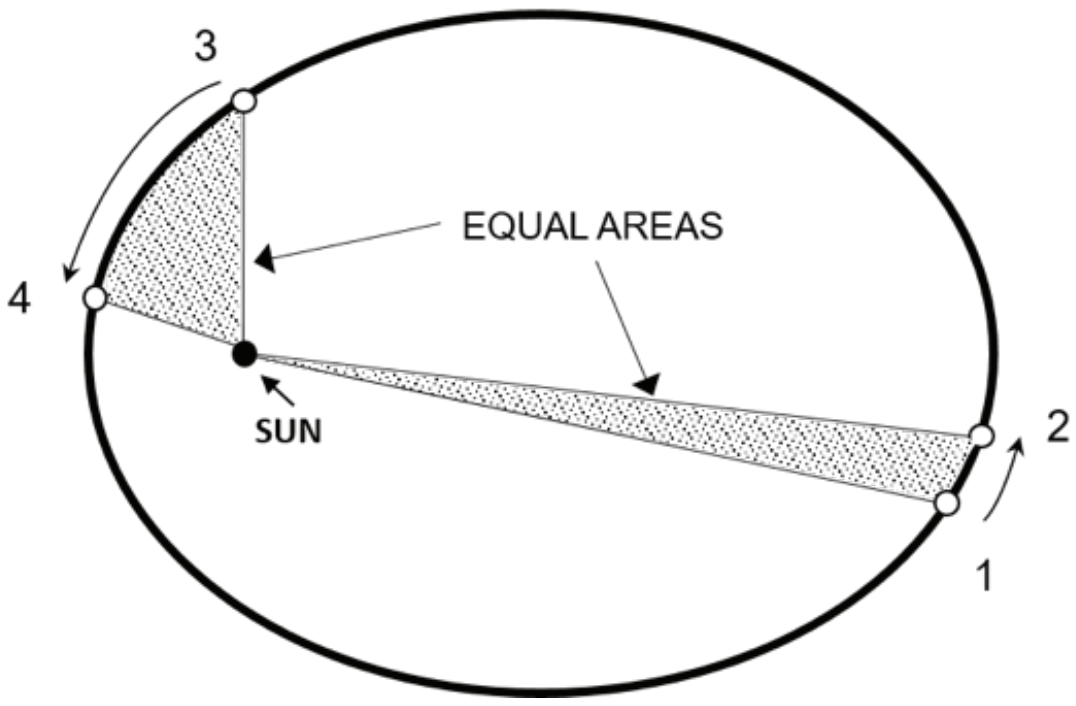
What's Up?

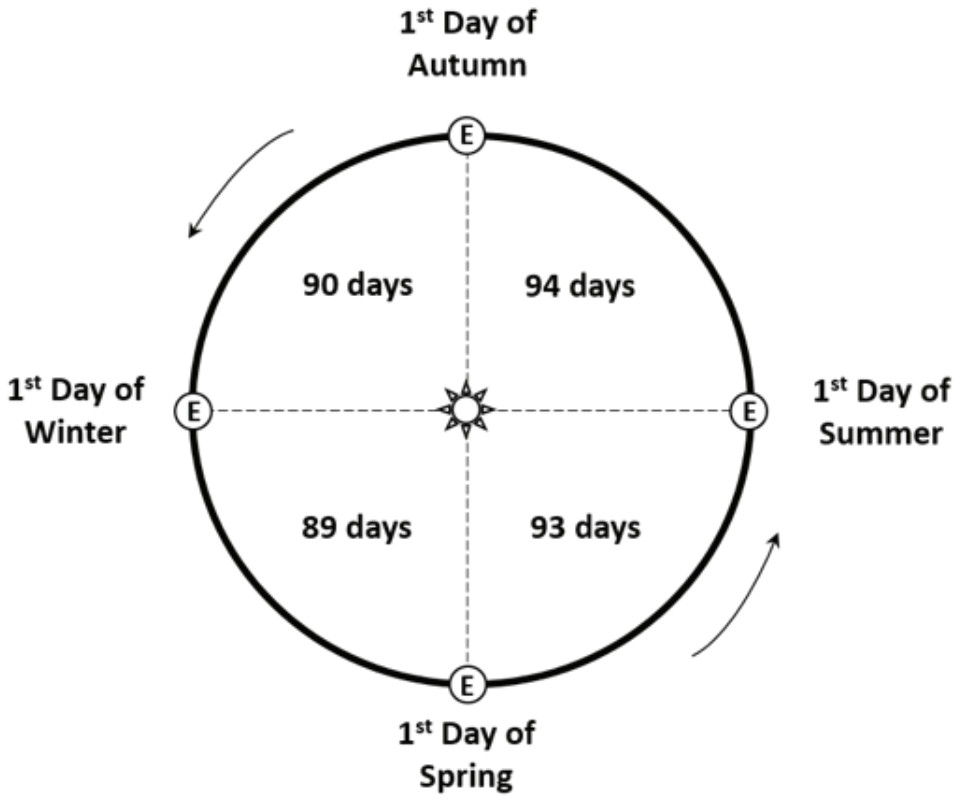
BY BARRY DECRISTOFANO

Hello. I hope you are all staying well. I also hope that my explanation of Kepler's 1st Law of Planetary Motion in the last article made sense to all of you. Here, I'll finish up by describing the 2nd and 3rd laws. The 2nd Law of Planetary motion says that, as the planets move, they sweep out equal areas of their orbits in equal times. This one is definitely best understood with a diagram. As 1st law tells us, the planets' orbits around the Sun are in the shape of an ellipse. For the sake of clarity, the ellipse that I'm using in the diagram is stretched out more than the actual orbits are. That is, this ellipse has a larger eccentricity than the planets' actual orbits have. Regardless of the orbital eccentricity, it takes a planet one of its years to go once around the sun. "Equal areas in equal times" means that since the distance from the Sun is constantly changing as the planet moves along, the speed at which the planet moves must constantly change, too. In order to keep the areas equal for a given amount of time, a planet must move slower when it is farther from the Sun, and faster when it is closer to the Sun. In the diagram, it would take a planet the same amount of time to move from 1 to 2 as it would to move from 3 to 4. The planet would move much faster when it was nearer to the Sun.



What makes a planet change its speed? Gravity. In simple terms, gravity is a mutual attraction between two bodies. Gravity is a force. The greater the amount of mass the bodies have, the greater the force. The closer the bodies are to each other, the greater the force. With the Sun at one of the focal points of the ellipse, as a planet moves closer to the Sun, the force of gravity between the planet and the Sun increases. This increased pull on the planets causes it to move faster. As the planet gets farther away from the Sun, the pull decreases and the planet slows down. Kepler, from analyzing the data he had, was able to discern the changing speeds of the planets. In fact, he realized that they changed speeds as they orbited the Sun before he knew that the shapes of the orbits were ellipses. The 2nd Law was actually described by Kepler before he confirmed the 1st Law.

Now, as I showed in my previous article, the Earth's orbit is not as stretched-out as the ellipse above. It's much closer to being a circle. However, it is not a circle. It is an ellipse and the Earth's speed around the Sun during the year follows the 2nd Law. You can see that this is so by looking at a calendar. Count the number of days from the first day of Spring to the first day of Summer. There are 93 days between March 19th and June 20th. Between June 20th and September 22nd (the first day of Autumn) there are 94 days. Between September 22nd and December 21st, there are 90 days. And, between December 21st and March 20th, 2021, there are 89 days. Because the Earth is closest to the Sun early January every year and farthest from the Sun in early July, our autumn and winter seasons are slightly shorter than our spring and summer seasons. The Earth is moving faster in its orbit from September to March than it is from March to September – we see the 2nd Law having its effect.



I'll let us all digest Kepler's 2nd Law and finish up with the 3rd Law next time. As to what's up in our skies, things haven't changed all that much since last week. One thing to note is how, over the next few days, the Moon will glide along the ecliptic passing through the constellation Leo the Lion as it changes appearance from a waxing gibbous Moon towards its Full phase. As I write this, I realize that I don't think I haven't yet talked about the phases of the Moon and why we see what we see. I'll make that the subject of a future article, for sure. In the mornings, the faster-moving Mars is now fully to the left of Saturn and Jupiter, with Saturn now in the middle of the three planets in the pre-dawn sky.

Errata: In my last article, I garbled a sentence. Instead of, "One note is that some folks, having learned in school the we have different seasons during the year is because the Earth's orbit is an ellipse.", it should have read, "One note is that some folks, having learned in school that the Earth's orbit is an ellipse, think that causes the changing seasons."

As always, you can reach me at astroblog@comcast.net. This is What's Up? Installment #17.

Keep looking up!

Barry