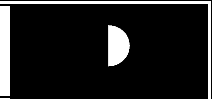
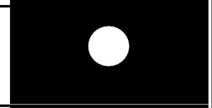
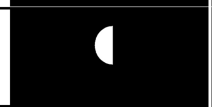
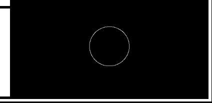
September Skies over the Pinnacles

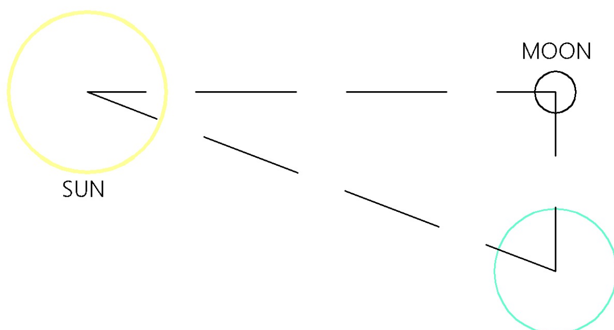
September 2022

September's Four Principal Phases of the Moon

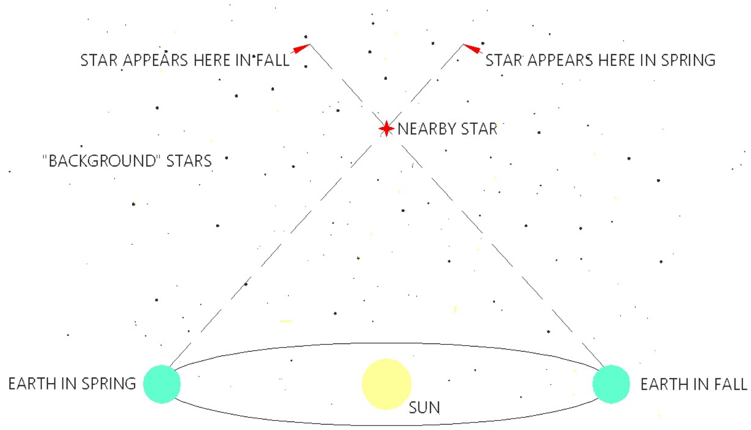
September 3	First Quarter	
September 10	Full Moon	
September 17	Last Quarter	
September 25	New Moon	

How Far Is That Star?

Have you ever wondered just how far away the stars around and above us really are? And how do they know? I remember my high school teacher telling me that if the orbit of Pluto (we thought Pluto was a planet back then) was shrunk down to the size of a basketball, the ***nearest*** star to our Sun would be over 4 miles away! So the stars are really *out there*. Even the planets in our own solar system are a long way off.

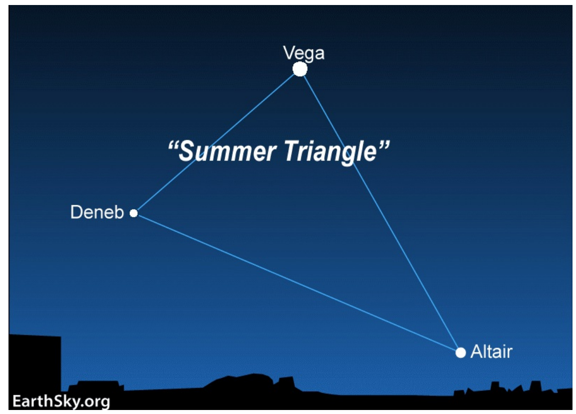


In the third Century Aristarchus on the Greek island of Samos tried to use a right triangle to measure the distance how far it was to the Sun compared to the distance to the Moon. Map readers call this triangulation. Nice idea but this told him that the Sun was 19 times farther away than the Moon. Actually, the Sun is more like 400 times farther away than the Moon. 20 centuries later, Johannes Kepler correctly figured out the distances of all the known planets relative to each other but he had no way of knowing the real distance of each planet from the Sun. That would come later by timing how long it takes the planets Mercury or Venus to travel across the face of the Sun during a rare transit across its face. This gave us the tool to find the actual distances from the Sun to each planet.



STELLAR PARALLAX

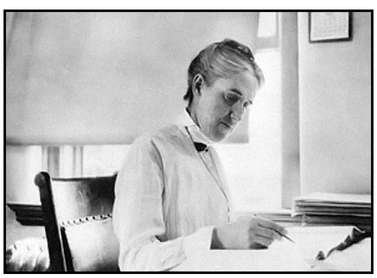
The first reliable way of measuring the distance to the stars used **parallax**. Try this. Point your finger at something really close to you in the room where you are sitting. Now close one eye and then the other. Notice how your finger seems to move back and forth a little as you look with just one eye and then the other? Now point your finger at something farther away, like a tree at the end of your street. Now when you look with one eye, then the other, your finger seems to move back and forth even more. The more your finger "jumps", the farther away the object you are pointing at. That's **parallax.** So we can use the diameter of Earth's orbit (about 300 million kilometers) to get two views of a certain star when the Earth is at opposite 'sides' of its orbit, about 6 months apart, and see if our star seems to shift its position compared to more distant stars. Using the parallax method worked great but it was not helpful in measuring the distances of stars that were farther away than about 300 light years. That's the distance light travels in 300 years. Our Milky Way galaxy is over 100 thousand light years across, so 300 light years is still in our own neighborhood.



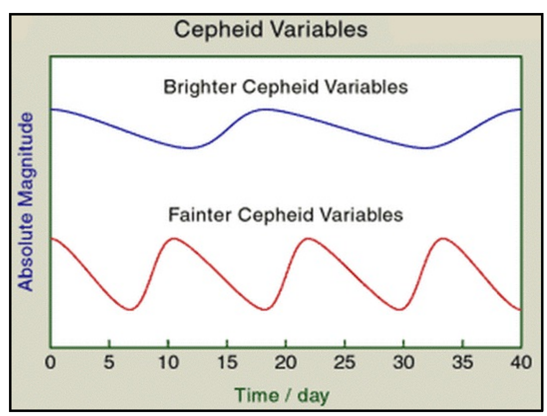
Now, if all stars shown at the same brightness we could just say, "...the dimmer the star, the farther away it is.". There is a precise relationship between the distance to a star (or your neighbor's porch light) and how much dimmer it gets as you move away from it. If you have 2 identical lights and one is twice as far away as the other, the more distant light will be 1/4 as bright. This is called the **inverse square formula**.

The Summer Triangle is high overhead this month. It is formed by the three stars, Deneb, Vega and Altair. Deneb, the most northern star doesn't appear nearly as bright as Vega, which is toward the west. Which is brighter? Vega. Which puts out the most light? Deneb! Deneb is 2,600 light years away and Vega is much closer, just 25 light years away.

We can only use the **inverse square formula** to tell distance to a star if we know how much light it puts out. That's called its **absolute magnitude**. How can we know how luminous a star is without knowing its distance and how can we know its distance without knowing its luminosity? Yikes!

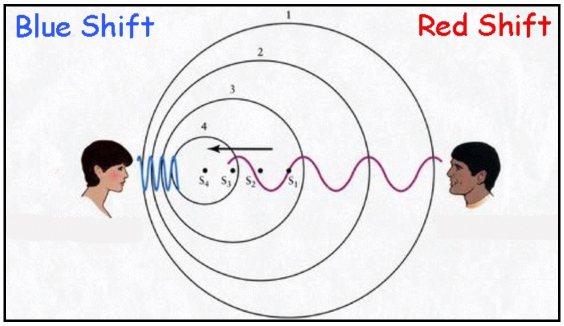


To answer this we need the brilliant (pun intended) work of Henrietta Swan Levitt. Ms. Levitt spent her life working at Harvard University cataloging images made of stars, many thousands of them over her career. She noticed that some stars changed their brightness over time in a sort of rhythm. She also found that some of these special stars were close enough to have their distances measured using the **parallax method**. She also found that some of the less bright close stars pulsated more quickly than the ones which put out more light. The first star discovered to behave this way can be found in the northern constellation called Cepheus. So other stars that behaved like this were called **Cepheid Variables**.



The Chart at right is a plot of fainter Cepheids, in red, compared to brighter Cepheids, in blue. Astronomer Edwin Hubble came along and used what is now known as the **Levitt Law** of Cepheid variable stars to prove how far away the Andromeda Galaxy is by finding Cepheid variable stars in that galaxy and then applying the inverse square formula to estimate the galaxy's distance of 2.4 million light years away!

The Andromeda Galaxy is among the closest galaxy to us and more distant galaxy appear as tiny smudges even to the Webb Space Telescope, the most powerful telescope on or off the Earth.

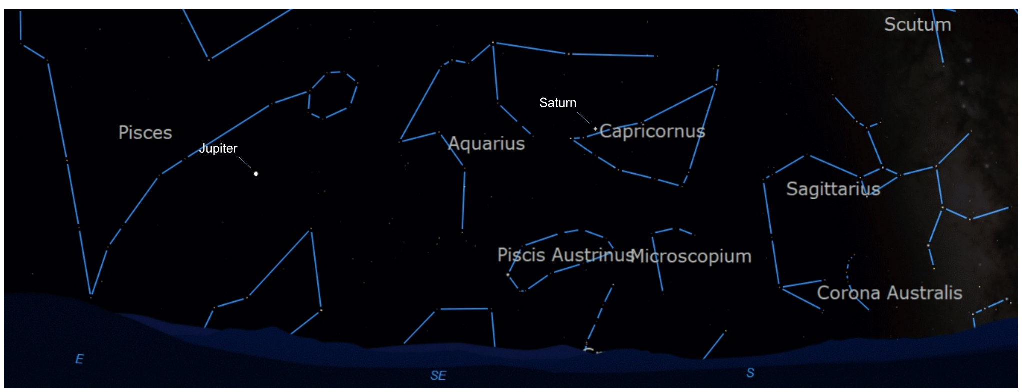


There's no way to see individual stars in these galaxies, some of which are more than 10 billion light years away. One way to get a rough guess is to measure their red shift. The faster a star or galaxy moves away from us the more the more light from it shifts toward the red end of the spectrum and the farther away it is. Almost no distant objects in space have a blue shift.

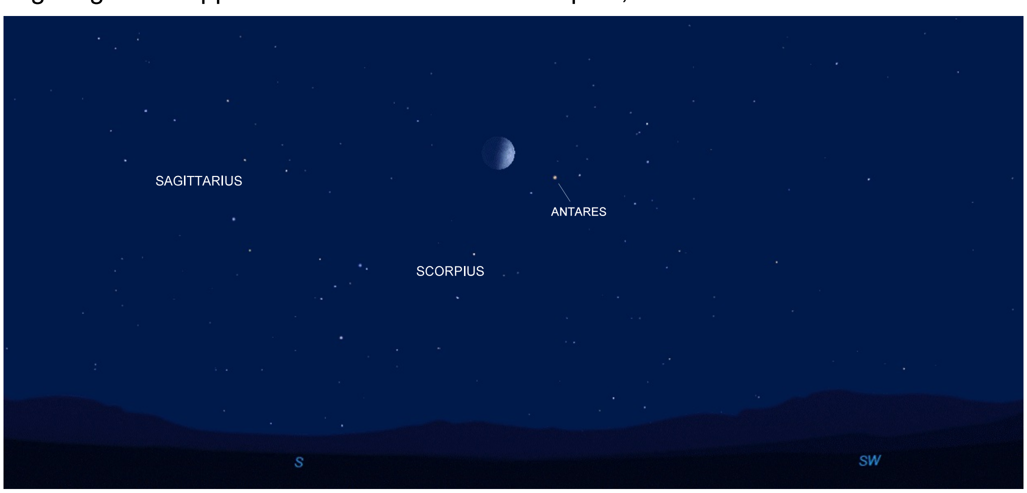
But here's the problem. It isn't really so much that the farther away these distant galaxies are the faster they are moving, but it is space, itself, that is stretching like taffy! Personal note: if space is stretching, then how do we measure distance? That's it. My brain is tired.

Attractions in September

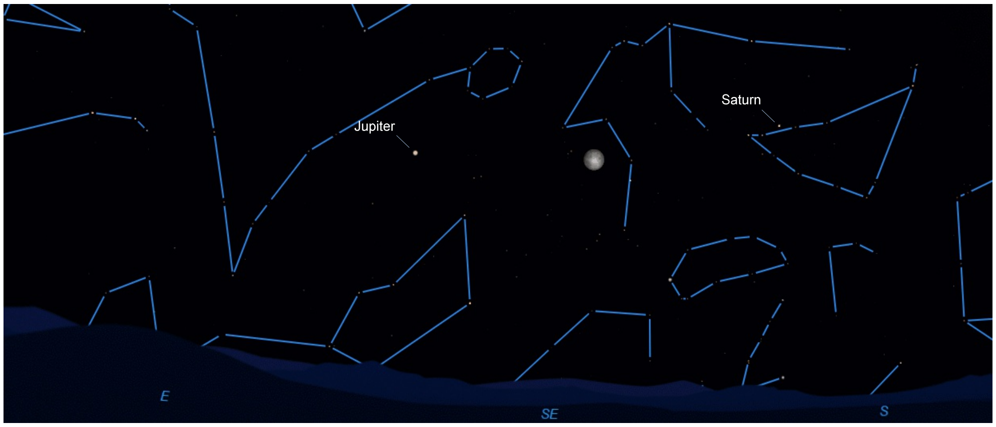
All Month Jupiter and Saturn return. Look for two bright "stars" that are visiting the constellations, Pisces and Capricornus.



September 3 Look to the southwest this evening and enjoy the pretty sight of the first quarter Moon lingering to the upper-left of the heart of the scorpion, the star Antares.



September 9 This evening you'll find the almost-fill Moon lingering between Jupiter and Saturn.



September 15 Stay up past midnight and check out a pretty trio in the northeast. It's red Mars, near the also-red star, Aldebaran. Above you'll see my favorite star cluster, the Pleiades and the waning gibbous Moon at right. Jupiter is hanging way above and to the right.

September 22 Fall Equinox! We'll have equal periods of daylight and night and Autumn begins!

September 30 The Moon pays another visit to the star Antares, this time, the pair is even closer than they were on September 3.