Skyward

June 2017

The partial phases of August's eclipse.

On August 21 this summer, the long shadow of the Moon will race across the United States, offering millions of people a look at the Sun's magnificent atmosphere, its corona. But for the millions more who do not make it to the narrow path of total eclipse, the Sun's light will still be partially cut off by the Moon. Everyone in the United States, and almost all of Canada, will see a partial eclipse that day. How much of the Sun will be covered by the Moon depends on where you live. Tucson, Arizona, to cite an example, will see a maximum eclipse of 58%.

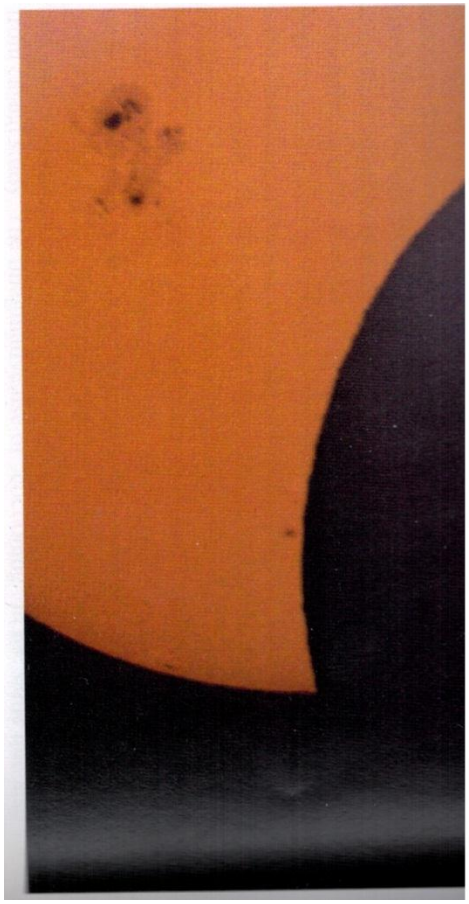
A partial eclipse lacks the drama of a total eclipse, but it is well worth watching nevertheless. The beginning is subtle. The Moon's first bite is barely noticeable, appearing at first as a tiny flat area cutting into the edge of the Sun. Within a few minutes that "line" becomes curved as the Moon cuts into ever-larger regions of the Sun. As the eclipse progresses, more and more of the Sun gets cut off. Within an hour, half the Sun will be covered and our star will take on the appearance of a crescent.

By this time you need to pay close attention to the warnngs about possible eye damage during a solar eclipse. Never look at the Sun without protection for your eyes. It is dangerous even when there is no eclipse. During an eclipse, the Sun's light is reduced, and you do want to gaze at it, but the dangerous UV is still there. (During the moment of total eclipse, and only then, is it perfectly safe to gaze at the Sun without protection for your eyes.) Most people have access to eclipse glasses fitted with strips of mylar plastic that offer excellent protection from the Sun's ultraviolet rays. If you do not have access to a pair, you can project the Sun's image through a pinhole onto a second sheet of paper or cardboard. But do not look through the pinhole. If you have a telescope, you can project the sun's image onto a piece of cardboard, a wall, or even the ground.

The closer you are to the path of totality, the thinner the crescent will get. If there is a tree nearby, try looking at the spaces between its leaves. You should be able to see dozens of cresecent Suns, each one projected through a space between the leaves. Their appearance is really quite wonderful. If the eclipse gets deeper than 80%, the sky will begin to darken slightly and a general sense of quiet will start to descend across the land.

After maximum eclipse, the story reverses. The sky lightens up, the crescent gets much wider, and after another hour the Moon leaves the Sun and the eclipse is over.

I know all these things because I have witnessed 90 eclipses since 1959, about 30 of which were either partial or the partial phases of total eclipses. An eclipse offers absolute proof that the Earth is moving through space around the Sun, that the Moon circles the Earth, and that because of a cosmic coincidence, the Moon and the Sun get in each other's way and that occasionally there is an eclipse. We are a part of this graceful movement. Eclipses teach us that we are a part of the solar system, and on August 21, throughout most of North America, we will get a first hand demonstration.



This is a view of the partial solar eclipse of October 23, 2014. By coincidence, the largest sunspot group 0f that cycle happened to be on the Sun that day. David Levy photograph.

July 2017

The Summer of 2017.

Summer is my favorite season, and Summer is also my favorite granddaughter. When I was growing up in Montreal, summer was the only time of year when the weather was warm enough to spend large amounts of time out of doors. With trees in full bloom, the quiet, sunny days of summer were really something to anticipate.

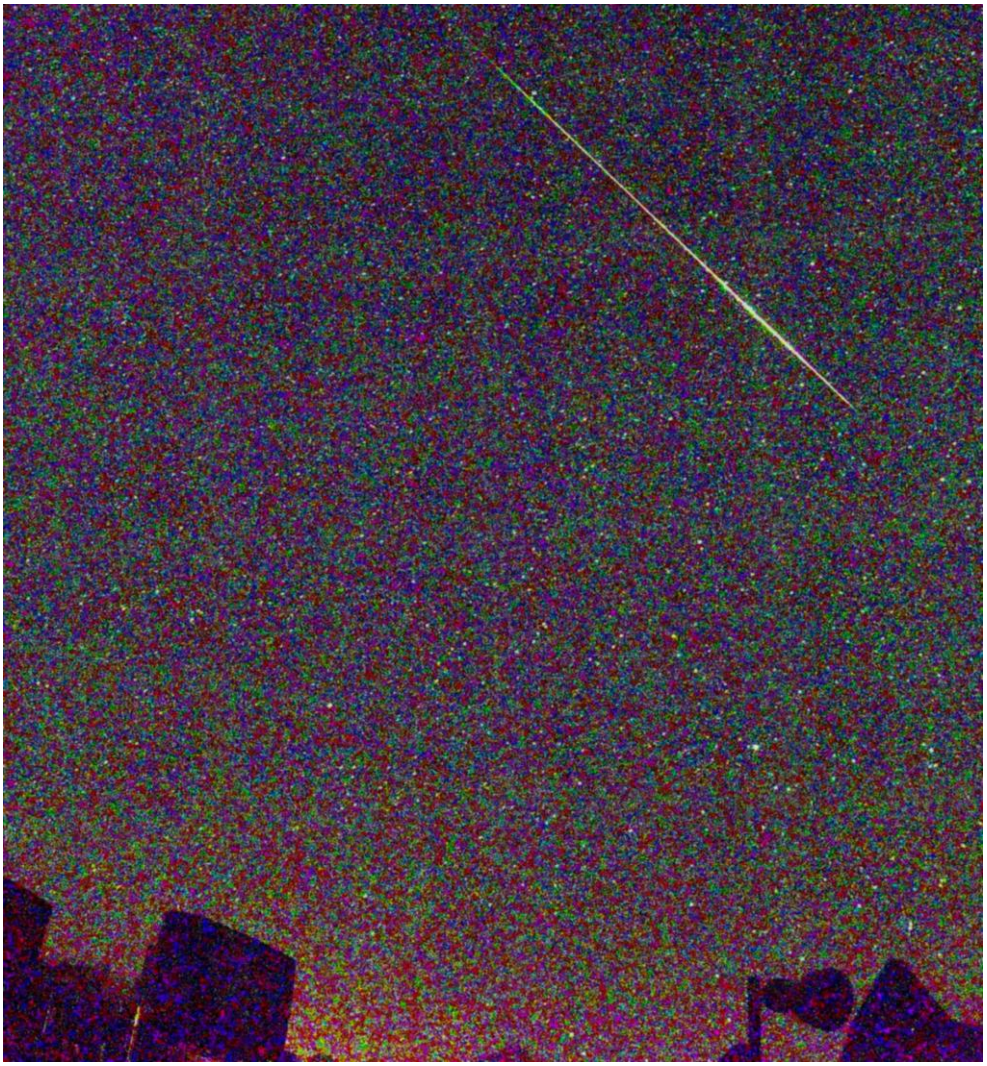
Summer in Arizona is different. With temperatures soaring well above 100 Fahrenheit degrees each day, going outside is an adventure fraught with peril. In fact, with a predicted high of more than 112 degrees last Sunday, I had to cancel my weekly bicycle ride and be careful to remain indoors as much as possible.

Further north, the temperatures are not quite as stifling, but on August 21, it won't matter. On that day the shadow of the Moon will work its way across the United States, giving viewers in the United States, for the first time in 38 years, a total eclipse of the Sun. The eclipse is the obvious highlight of the summer of 2017. But as hot as the days of summer might get, the nights offer the real blessing. When the sky is clear enough, the predawn temperatures remain in the pleasant 70s. Saturn, with its exquisite rings visible even through a small telescope, shines brightly in the evening hours. The Milky Way arches overhead like a highway. And sure enough, in the constellation of Cygnus the swan, a great dark rift resembles an exit ramp, pouring starlit traffic off that highway amongst the stars of Ophiuchus.

There will be two big meteor showers this summer. Around July 21 the Delta Aquarid meteors will visit, emanating as lovely, fast-moving streaks of light coming from the constellation of Aquarius. Just two weeks later, the Earth will cross the orbit of a wondrous comet. Discovered in 1862 by Louis Swift and Horace Tuttle, this comet's orbit crosses the Earth's path every 120 years, at which time we encounter a stream of meteors called the Perseids.

Finally, this summer will offer something unique besides the eclipse. On July 30 the Earth will cross the orbit of Comet Borisov, a large comet I observed two years ago. When that happens there may be yet another meteor shower, visible best for observers in southern Europe and Africa. But could there be some meteors here as well? No one really knows; the best thing to do is to watch and see.

Wherever you are this summer, the sky offers a cornucopia of wonderful things to see, and for most of what I have suggested, you do not even need a telescope. Simply enjoy the evenings and the nights, look toward the sky, and enjoy the cosmic sea of which we are a part.



A Perseid meteor scratches the sky for a second or so about 100 miles above the Earth. David Levy photograph, Summer 2016.

August 2017

Anger issues, however inappropriate

With cloudy night after cloudy night passing us by this summer, one wonders whether it would be appropriate to hit a baseball onto the floor or something to encourage the sky to clear, if only for an hour or so, on any one of these mild summer evenings. I used to take cloudy weather personally, and when I was much younger I had quite a temper.

In August of 1962 (I was 14 then) I carried my typewriter by bicycle to Summit Park, a beautiful wooded park atop a small hill not far from my family home. I was writing one of my first astronomy books, a little too confidently entitled *An Encyclopedia of the Universe*, and had just begun page 260 in the chapter about double stars. About halfway down the page, some minor problem befuddled my typewriter, and I had what I now call my "double star tantrum." Repeatedly striking the little typewriter against the maple tree under which I was sitting, there was nothing to do but cycle everything home.

The next morning was another day, however. I asked Mother if I could borrow her typewriter, claiming that mine had been somehow damaged. I cycled back to the same tree, placed the bottom half of the torn sheet of paper into the typewriter, and calmly resumed typing.

The original typewriter was repaired while I was living in Denver at the Jewish National Home for Asthmatic Children. (Whatever did you do with your typewriter?" Dad wrote to me. "It cost me $50 to repair it!" Some ten years later, with my passion for astronomy still at a maximum, my brother Gerry gave me a poster with a quotation from Henry David Thoreau, one of my favorite writers. It is from the conclusion of his book *Walden*:

> If a man does not keep pace with his companions, perhaps it is because he hears a different drummer. Let him step to the music which he hears, however measured or far away.

Carrying those wonderful thoughts in my mind, I returned to Summit Park and photographed the tree still healthy and pointing skyward to the stars I love so much. On these summer evenings, the tall tree points roughly toward Vega, the brightest star in the summer sky and a member of the Summer Triangle.

Very close to Vega is a famous double star called Epsilon Lyrae. It consists of two stars close together, each of which is in turn accompanied by a faint companion.

Perhaps because of that incident from long ago, I have become a fan of double stars and am still observing them, enjoying their different colors and trying to separate them with my telescopes. I like to think that in my declining years, that my anger issues have been resolved, but what I don't forget from that day is that the afternoon ignited a strong interest in the many stars in our sky that have companions, circling each other as they parade through our galaxy.

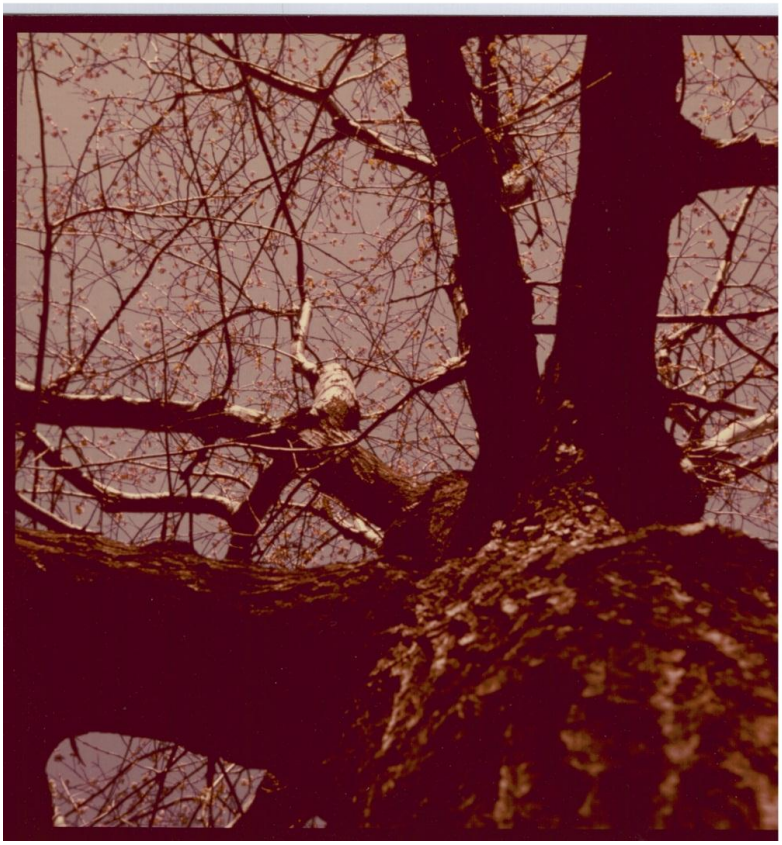
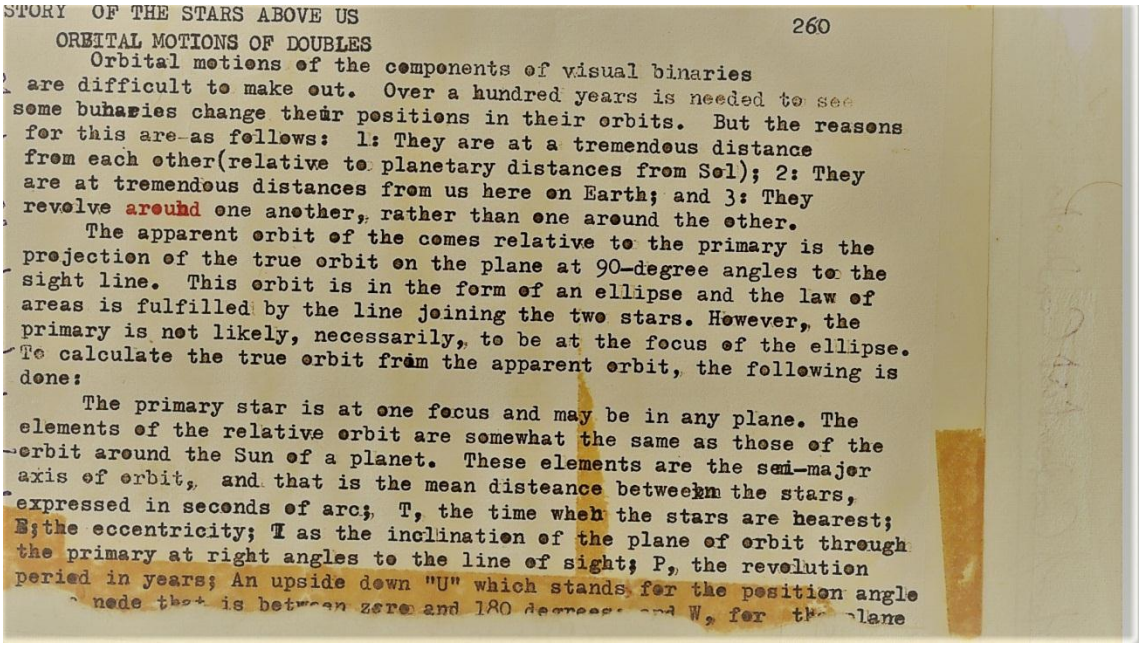


Figure 1 is the actual tree into which I banged the typewriter.



STORY OF THE STARS ABOVE US 260

ORBITAL MOTIONS OF DOUBLES

Orbital motions of the components of visual binaries are difficult to make out. Over a hundred years is needed to see some buhaaies change theur positions in their orbits. But the reasons for this are as follows: 1: They are at a tremendous distance from each other(relative to planetary distances from Sol); 2: They are at tremendous distances from us here on Earth; and 3: They revolve arouhd one another, rather than one around the other.

The apparent orbit of the comes relative to the primary is the projection of the true orbit on the plane at 90-degree angles to the sight line. This orbit is in the form of an ellipse and the law of areas is fulfilled by the line joining the two stars. However, the primary is not likely, necessarily, to be at the focus of the ellipse. To calculate the true orbit from the apparent orbit, the following is done:

The primary star is at one focus and may be in any plane. The elements of the relative orbit are somewhat the same as those of the orbit around the Sun of a planet. These elements are the semi-major axis of orbit, and that is the mean disteance betweehn the stars, expressed in seconds of arc; T, the time wheh the stars are hearest; E;the eccentricity; I as the inclination of the plane of orbit through the primary at right angles to the line of sight; P, the revolution period in years; An upside down "U" which stands for the position angle node that is between zero and 180 degrees; and W, for the plane

Figure 2 is the original of the sheet of paper I tore out of the typewriter

David H. Levy

U.S.A.