Being Close Makes The Moon More "Romantic"

By Alex McConahay

Judy and I were celebrating our 30th anniversary last month as we watched the bright yellow moon rise over the horizon. "Oh, look at that big, beautiful moon," she whispered. "Isn't that romantic!"

"Well," I explained, "Many people think the moon is bigger when they see it near the horizon. It is called the 'lunar illusion.'" I went on to explain that the moon is really no larger when seen on the horizon than it is at zenith. I said you could prove this by holding your finger up to it on the horizon, and noticing that it covers about half the width of your finger (about half a degree), and when the moon is high later, you could hold that finger at arm's length and see the moon was the same width. "Wow," she sighed, "I'll look forward to doing that."

I spent a few minutes explaining that the brain compares the moon on the horizon to the trees, hills, and houses in the foreground, and decides that the moon must be very far away, and therefore, must be really large. Conversely, some people cite a different mechanism using the same foreground contrast: the brain tells us (incorrectly) that the moon is the same distance as those objects, so must be really close, and therefore large. The newest theory, I continued, is that the *lack* of foreground objects when the moon is high makes the brain think the moon is isolated in the sky, and this makes it look smaller in the large sky. In short, I said, nobody has really explained the moon illusion.

The full moon when closest to the earth (perigee) is about 14 percent larger in apparent diameter than when at it's farthest from the earth (apogee). August, September, and October of this year feature the full moon at a closer than usual perigee because the earth-moon system is relatively close to the sun at this time of the year.

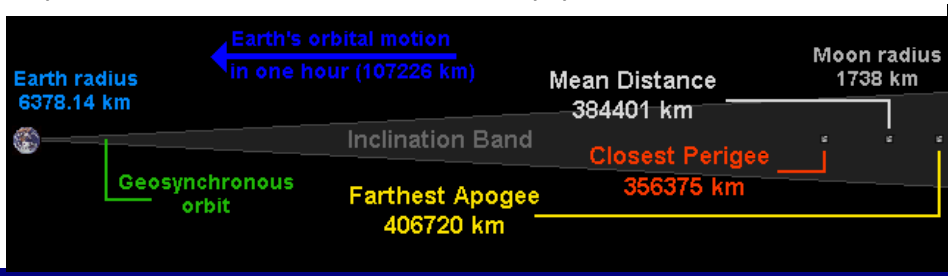
Actually, I continued, the moon is ever so slightly larger when at zenith than when at the horizon. When viewing the moon at zenith, one must look at the earth surface-moon surface distance. But when viewing the horizon moon, one must add the distance from the observer to the earth surface directly under the moon--roughly 6300 kilometers. (I did not get into the exact angular geometry). So, a horizon moon is that distance further away than a zenith moon (1.6 per cent or so) and so slightly smaller.

"Well," she murmured, "I still think it is pretty and bright."

"Actually," I said, "the albedo of the moon is only about 7 percent. That means most of the light is absorbed, and only 7% is reflected back to our eyes." I spent a few minutes explaining that the moon is about as bright as parking lot asphalt at noon, but considering that the rest of the sky is so dark, and our pupils are so dilated, it looks really bright.

"Oh," said Judy. But I knew what she really meant, she wanted to know more about why the moon looked so big. Luckily, I had saved

The distance from the earth to the moon varies depending on the eccentricity of the moon's orbit and the tidal action of the sun.
http://www.fourmilab.ch/earthview/moon_ap_per.html



the best for last. The moon's apparent size that night really *was* larger than usual because the moon was so close to the earth. The closer an object is, the bigger it looks. The moon was, I told Judy excitedly, only about 361, 247 kilometers away (94% it's average distance), and so appeared 6% larger than average. I told her that the size of the moon can appear to change as much as 14 percent depending on where it is in its orbit.

Judy's eyes seemed to be glazing over, probably from all the moon observing she was doing. But I just had to tell her about how the moon's orbit was never really circular, but instead a not quite round ellipse. This oval shape was about 5.49% longer than it was wide, and so the moon naturally would have times when it is closer (perigee) and further (apogee) from the earth. Then I explained that the sun also had a great tidal effect on the moon moving thorough space. The sun's gravity pulls the moon even further away from the earth when the moon was closer to the sun, and closer to the earth when the moon was further away from the sun. So, the distance of lunar apogee and perigee changes according to the relative position of the sun, moon, and earth.

By the way, I added, that little extra closer the moon also affected the moon's brightness a little. Since the moon was closer to the earth, and light intensity falls off as the square of distance, the moon actually appeared brighter than usual. (I did not go into the fact that the clear weather we were having probably had more to do with it because I did not want to spoil the moment. Besides, I was just getting going on orbital dynamics.)

Sometimes, I continued, because the earth's orbit is also elliptical, the earth-moon system is closer to the sun, and therefore, the tidal effect is even greater. So, a full moon at perigee in July (when the earth is closest to the sun--Perihelion) is just that much bigger than one at apogee in January (when the earth is farthest from the sun--Aphelion.)

And of course, I answered Judy's next question before it was even asked. Due to the movement of the lunar orbit, the point at which the perigees and apogees take place actually rotate around the earth in about a nine year cycle, and the period between one perigee (or apogee) and the next is about twenty seven and a half days (an anomalistic month). Of course, I then had to explain the different kinds of "months". And all this means that the apparent size of the full moon changes constantly. Wow!

"Well," I thought, "it's great, spending an evening under the full moon together." By now the moon had risen high overhead and Judy wasn't saying much (actually she had apparently already gone in). I cannot wait until this month when the full moon will be only 357,295 kilometers away, or October, when it will be only slightly further off. Imagine how big that thing will look then! I just can't wait to see it!

September and October Full Moons will also be larger than usual. For more information, go to:

http://www.inconstantmoon.com/

http://www.fourmilab.ch/earthview/moon_ap_per.html

http://www.minervatech.u-net.com/moon/not_libr_ac.htm

This illustrates how the relative distance of the moon-earth distance changes depending on lunar position in its orbit and solar tides. When the moon's orbital apogee coincides with a full moon (as in October 2002) the sun's tidal forces (which have less effect since the moon is further from the sun than the earth is) exaggerate the distance between the earth and moon. At this point, the moon will appear relatively smallest. Compare this to June, when the full and new moons happened when the moon was at about an average distance from the earth and the tidal forces were not as strong. The difference between the smallest and largest full moons can be as much as one-seventh of a lunar diameter .