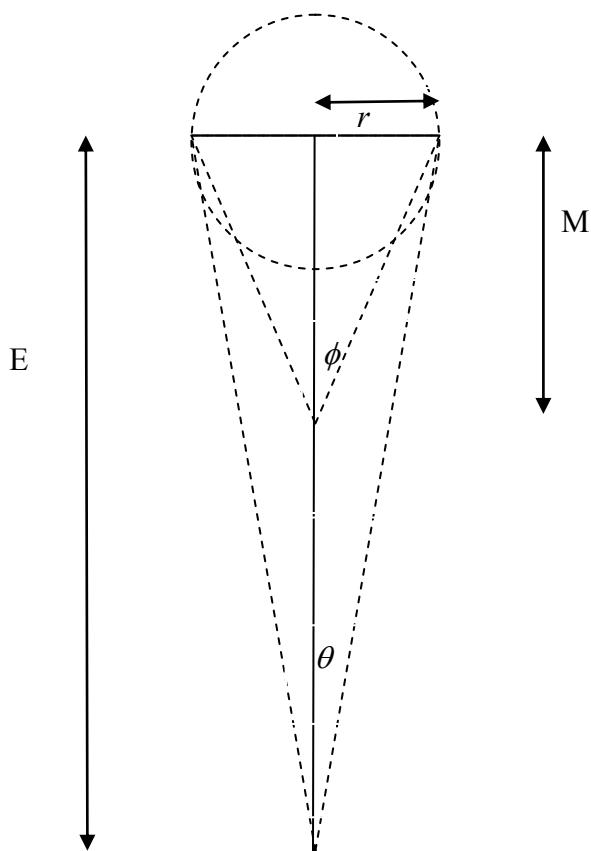


Thoughts of Astronomy on Palm Sunday

As I write this, it is Palm Sunday. Earlier in the middle of breakfast, I wanted to verify that from the surface of Mercury the sun would appear 2.5 times bigger than it does from the Earth. But my wife wanted to go to church, and to avoid an argument, I complied. While stalling, I reminded myself that an object seems to shrink as it recedes from view because the angle emanating from you to the edges of the object gets smaller.



Half of the object's diameter in this case is the sun's radius, r . M is the distance between the sun and Mercury and E is the earth-sun distance. Using simple tangent ratios, the relative apparent size of the sun on Mercury is given by

$$\phi/\theta = \frac{\tan^{-1}(r/M)}{\tan^{-1}(r/E)}$$

For very small angles, $\phi/\theta = M/E$, so in other words because Mercury is 2.6 times closer, the sun appears 2.6 times bigger.

Calculating it either way yields

$$\phi/\theta = \frac{\tan^{-1}(695\,500\text{ km}/57\,900\,000\text{ km})}{\tan^{-1}(695\,500\text{ km}/149\,597\,871)} = 2.583622699 = 2.58$$

$$M/E = 2.583728342 = 2.58$$

While sitting in church, I thought of a way of mentally estimating the size of the sun. The moon and the sun appear to be the same size in the sky. That means that the size-ratio of the sun and moon approximately equals the ratio of the sun-earth distance to that separating the earth from the moon. I remembered that the moon was about 225 000 miles from the earth compared to about 93 million miles for the astronomical unit (earth-sun distance). $93\,000\,000/225\,000$ without a calculator was close to 400. Our planet is about 4 times bigger than the moon, which puts the sun-diameter at about 100 earth diameters. The diameter of the earth is about $24000/\pi$ miles * 1.6 km / mile, so the sun is approximately $100 * 24000/\pi * 1.6$ km in diameter

After church, I confessed to my wife and daughter that although I heard most of the sermon, I had also estimated that the sun was $200 * 24000/\pi * 1.6$ km wide. I mentioned that if God exists he likes astronomy and would not mind my wandering thoughts. On our way home, I pulled the calculator out of the glove compartment and $100 * 24000/\pi * 1.6$ yields a diameter of 1 220 000 km corresponding to a radius of 611 000 km.

If we use the more accurate earth-sun distance of 149 597 871 km and the corresponding earth-moon distance of 384 400 km, we get the sun equaling 389 moon diameters. The real earth-moon ratio is $6378.1\text{ km} / 1737.4\text{ km} = 3.67\text{ km}$. So the sun would be $389/3.67 = 106.1$ earth diameters wide.

This spells out a radius of $106.1 * 6378.1\text{ km} * 2 = 676\,148$ closer to the expected value of 695 500 km , an error of 2.8%

In reality, the sun appears to be 31/60 degrees in the sky. The moon is only 30/60 degrees wide. The assumption that they are equal introduces an error of $1/60 = 1.7\%$.

$\tan^{-1}(695\,500\text{ km}/149\,597\,871)$ predicts a radius of 0.266 degrees which corresponds to an apparent diameter for the sun of 0.532 or 32/60 degrees.