Lab #13b: Distance to the Moon (Lunar Parallax)

PROCEDURE AND LAB REPORT

Date:_______ Your name: ___________Partner's name: ___________ Section: ___/___

Maximum two students may work together as partners!

Read:

In the laboratory we'll use the *daily parallax* of the Moon to determine its distance.

First, you'll look at two pictures of the Moon taken on Sept. 5, 2004, when the Moon passed close by the Seven Sisters. You'll determine how fast the Moon was moving and calculate how fast it should be moving due to its monthly orbital motion. There will be a discrepancy, which you'll calculate. The discrepancy is due to the fact that we are watching the Moon from a spinning Earth and we are in fact moving quite fast, from West to East. We'll calculate how fast we are moving, and relating that to the discrepancy this difference is supposed to explain, we'll find the distance to the Moon.

Procedure:

(1) Look at the two pictures. The stars have turned in the two hours between the times when they were taken, and the Moon has also moved in relation to the stars. The easiest way to determine this motion is to place a sheet of tracing paper over your pictures and copy the stars and the two positions of the Moon on the same sheet. Each time, align the stars with each other. Notice the faint star on the bottom of the picture: it will help you to find the precise alignment of the two pictures. Now, on the tracing paper, you will see how much the Moon has moved. Measure the distance with a ruler: _____ *mm*. Now, you will need to find out how many degrees this movement corresponds to, and the easiest way to do that will be to compare it to the known size of the Moon. Measure the diameter of the Moon in the picture: _____ *mm*. From this, knowing that the diameter of the Moon is in fact *0.5 degrees*, you conclude that the Moon has actually moved _____ *degrees* in two hours, which is _____ *degrees* per hour.

(2) Now calculate how much the Moon was supposed to move due to the fact that it revolves around Earth. In 27.322 days it makes a full circle (*360 degrees*), so it moves _____ *degrees* a day, so _____ *degrees* per hour.

(3) Now calculate the discrepancy between how fast the Moon is *supposed* to move and how fast it actually moves. If you did the calculation correctly, it will actually be moving slower than it is *supposed* to move. The difference is _____ *degrees* per hour. At this rate, it takes *t* =____ *hours* for the difference to become a half a degree.

(4) This difference is due to the fact that we are watching the Moon from a spinning Earth. In fact Earth is rotating West to East one turn a day. The length of the equator is 40,000 km, so the speed of spin of a point on the equator is 40,000 km / 24 hours = _____ *km/h* =_____ *mph*. Mississippi, being north of the equator, moves with 82.51% of this speed, which is _____ *km/h*.

(5) With this speed, in *t*=____ *hours* (copy!) Mississippi moves a distance of *x*=____ *km*, and the discrepancy becomes a half a degree. We know that anything that looks a half a degree in size is a 100 times farther than its size, so we conclude that the distance to the Moon is *100 x*=________ *km*.

(6) Is your result reasonably close to the actual distance to the Moon, which varies from *369,600 km* to *404,500 km*? Is this a precise method to determine the distance to the Moon?

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(7) These pictures were taken with an f=180 mm telephoto lens at f/8, piggybacked on an equatorially mounted LX200 telescope, on regular 100 speed film (24 mm x 36 mm). A careful examination might even detect the inaccuracy of the tracking. Notice the star in the bottom of the picture!