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Clearing a lunar

Subject: Clearing a lunar
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Several weeks ago I started a posting that was intended to show how my method of clearing the lunar distance works. Other things intervened, and the effort was abandoned. Coming back to it, I've decided to divide the explanation into two postings. This one will deal with the general idea behind the method of clearing. A later one will focus on the Tables.

Like the methods devised by Dunthorne, Borda, and Kraft, the method used in the Tables is rigorous. The distance is cleared with an oblique spherical trigonometry equation. The equation was derived by combining two other oblique spherical equations. Those two can be found, in one form or another, in navigation manuals back to, and including, Maskelyne's Requisite Tables.

But I'll put individual methods aside for now, and use this posting to give a quick review of the lunar distance, and the general idea behind the rigorous methods of clearing. How you convert a cleared distance into GMT will be explained in the second posting.

Pick an object more or less in line with the moon's monthly circuit through the celestial sphere. The angle between the moon and that object will be changing about one minute of arc every two minutes of time. And every measurement of the angle will correspond to a particular instant of GMT.

Let's say the object is a star. With your sextant, bring the moon's enlightened limb to the star, letting the two brush past each other in the horizon glass to make sure there's a contact, but no overlap. Note the watch time of the contact. Since this is a bare-bones explanation, we'll use this single measurement rather than the average of a number of contacts.

First, adjust the measurement for sextant error. That is, apply the index correction and any correction given on the certificate in the sextant box. Next, apply the moon's augmented semidiameter. Augmentation has to do with the fact you are generally a bit closer to the moon than the center of the earth is, so she appears slightly larger to you than she does from the Nautical Almanac's perspective. When the moon is directly overhead you are closer by the full radius of the earth. At such times, augmentation can amount to as much as three-tenths of a minute of arc. Add or subtract the augmented semidiameter, according to whether the moon's enlightened limb faces toward, or away from, the star.

You now have the apparent distance. The question is: How do you adjust it for refraction and parallax?

Refraction and parallax operate in the two vertical circles, one of which passes through the moon and your zenith, the other through the star and your zenith. If it just happens there is only one vertical circle, that is, the moon, star, and zenith are all in same great circle, refraction and parallax can be applied directly. They will have 100% effect on the distance. At the other extreme, suppose the plane of the distance is perpendicular to one of the vertical circles. Let's say the angle at the moon, where the plane of her altitude and the plane of the distance meet, is 90°. The moon's refraction and parallax will have little, if any, effect on the distance.

Clearly, the angle formed at a body, where the vertical circle and distance circle meet, is the main factor determining what percent of its refraction and parallax show up in the distance. The approximate methods of clearing focus on these angles, calculating corrections, and corrections to corrections, to apply to the distance. Rigorous methods, on the other hand, calculate the true distance itself. For either method you need altitudes but, fortunately, the accuracy of the altitudes is not critical. Within five arc minutes will do fine, and larger errors seldom cause trouble.

Suppose you want to clear your distance the rigorous way, but without using one of the procedures designed for the job. You have the three sides of the apparent triangle formed by your zenith, the moon, and star. The two apparent altitudes, or rather, their complements, form two sides. The apparent distance forms the third side. With these, calculate the angle at your zenith. Obviously that angle isn't changed when the altitudes of the moon and star are adjusted for refraction and parallax, so the zenith angle is the same for both apparent and true triangles.

With the zenith angle and the true altitudes you now have the three parts you need to solve the true triangle. Solve it for the third side. That will be the true, or cleared, distance.

Solving two oblique spherical triangles one at a time is not the easiest way to clear a distance. But it's a transparent operation, and shows the logic of the rigorous approach.

How the cleared distance is converted to Greenwich time can be explained in relation to the Tables for Clearing, which I hope to write about in another posting.

Bruce

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