Navigational Astronomy

FOUR THINGS TO REMEMBER

Grasp These and You Have Heart of the Matter! (apologies to Evelyn Waugh)

PTOLEMY WAS RIGHT!

The first thing you have to know about celestial navigation is that its view of the heavens is pre-Copernican. That's right – you look at the earth as the unmoving center around which the sun, moon, stars, and planets turn. In other words, we deal with the heavens as if wysiwyg (what you see is what you get).

[Digression: Your webmistress gets to do this because this is MY page! Does the earth revolve around the sun, rather than vice versa? If I remember my high-school physics, the two bodies actually revolve around a common center of gravity, which, because of its massive size, happens to be located inside the sun. And is pre-Copernican astronomy "wrong?" We now have non-Euclidean geometries, but we still use no more than we know under Euclidean geometry to draw the lines on baseball fields, for example. I don't want to start another page on the philosopher Ludwig Wittgenstein, but if the "language game" – in this case, that of Ptolemaic astronomy – has a valid use, then there is nothing "wrong" about it. Read C.S. Lewis's ***The Discarded Image****. Digression over]*

EINSTEIN WAS RIGHT!

Space and time are a continuum! In celestial navigation, time=distance. Longitude is measured in degrees, and each 15 degrees is equal to one hour (so 360 degrees equals 24 hours – one hour of the rotation of the earth corresponds to 15 degrees angle of the earth's rotation). One second of time is equal to roughly 1/4 mile at the equator, and this is why an accurate watch – one which you know the exact error of – is so important. An error in time will equal an error in longitude.

**Please note my disclaimer that this was an attempt to be witty; the space-time continuum of Einstein's Special and General Relativity has nothing to do with the fact that we can measure an angle as an astronomical coordinate based on the rotation rate of the earth. I merely mean for you to notice that there is something about the way navigation treats time and distance that is not the usual way we think of them. Reasonable people will not disagree about Einstein, but they WILL disagree about your webmistress's wit or lack thereof!*

THE TRIPLE COORDINATE SYSTEM

Earth's:

Everyone is familiar with the earth's system of coordinates: the equator, at 0 degrees, belts the earth, and ***latitude lines*** *running parallel to it circle the earth to the* ***North Pole*** *from 0 to 90 degrees for North Latitude and from 0 to 90 degrees to the* ***South Pole*** *for South Latitude. Vertical circles –* ***longitude lines*** *– run the other way, beginning at 0 degrees at the* ***Greenwich Meridian*** *running through Greenwich, England, and circling 180 degrees to east for East Longitude and 180 degrees to the west for West Longitude. Each degree can be further subdivided into 60 minutes, and each minute into 60 seconds (3600 seconds per degree). With this grid system, we can pinpoint the location of anything on earth by giving its latitude and longitude. For a landmark or location on earth, those numbers do not change.*

Celestial Body's:

For the second grid system necessary for Celestial Navigation, imagine a great crystal globe encircling the earth. If you imagine the equator extended into space, that line will mark the ***Celestial Equator****. What would be latitude lines on earth become lines of "****declination****" in space, and like latitude lines on earth, they measure angular distance north or south of the celestial equator (0 degrees) to a* ***North Celestial Pole*** *and a* ***South Celestial Pole*** *– extensions into space of the earth's poles. What we would call longitude lines become "****hour circles****" on the celestial sphere. The 0 degree hour circle (or celestial meridian) is the* ***First Point of Aries;*** *a difference from earth's longitude lines is that these lines are numbered to the full 360 degrees, rather than 180 degrees east or west.*

Observer's

The third coordinate system is completely dependent upon the observer. Imagine (as all children – and some adults – do) that we ourselves are the center of the universe, the point from which all others take their bearings. The point directly over my head (which moves with me, even if I take a single step) is my "pole," or ***zenith****. Its opposite, beneath my feet, is the* ***nadir,*** *a term which has little place in celestial navigation. My "equator" is my* ***horizon****, at 0 degrees. The distance above my horizon, rather than being called latitude, is called* ***altitude*** *(and altitude – up to 90 degrees – is what we measure with a sextant and other navigational instruments). The imaginary line running from my zenith due north or south to my horizon is my own meridian.*

It's much better to visualize these coordinates than describe them. Try Walter Fendt's Apparent Position of a Star site, or the figures in the celestial navigation chapter of Bowditch's American Practical Navigator. There are some good line drawings at Astronomy without a

Telescope.

HOUR ANGLES

*Geographical Position (**GP**) – imagine a string stretched from the center of the earth, through its surface, and into the center of the celestial body. The point at which in passes through the earth's surface is its geographical position. This information is in the Almanac for every day, hour and minute of the year.*

*A body's GP's distance from the Greenwich Meridian is its Greenwich Hour Angle (**GHA**). A body's GP's distance from where WE are is its Local Hour Angle (**LHA**). For sight reduction, we want the last, the **LHA**, to enter the Sight Reduction Tables (see Practice).*

*The Almanac gives us the **GHA** of everything but the stars – that would take up too much room – and instead gives us the **SHA** (a star's distance from the First Point of Aries is its Sidereal Hour Angle or **SHA**), which we can then convert, and worksheets help us figure the **LHA** by using our longitude.*