Sky & Telescope's LEA: The Orbit of Mars

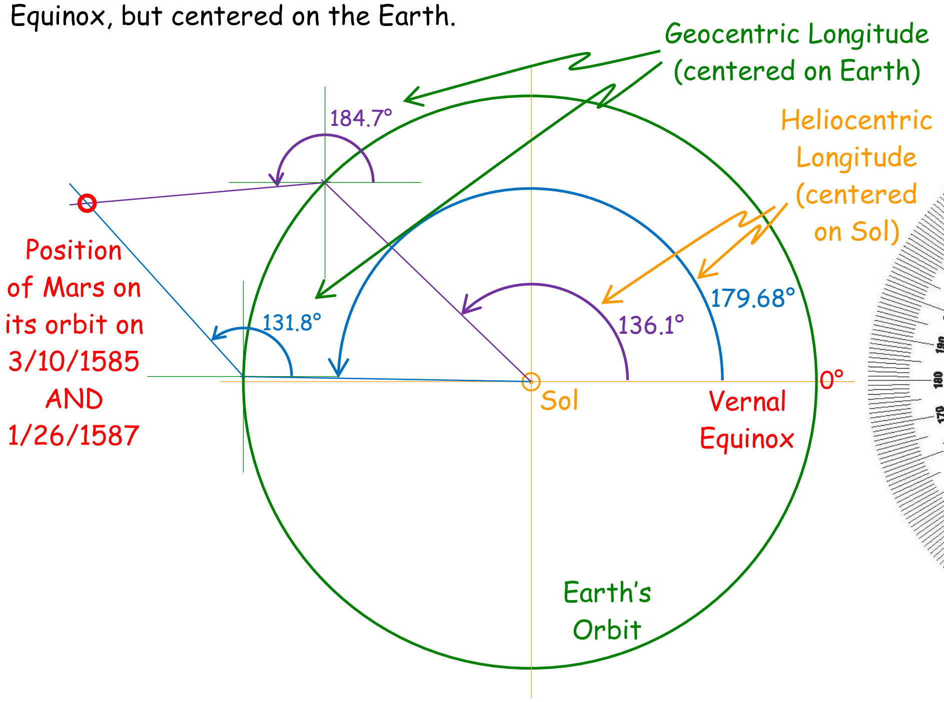
Kepler's Data

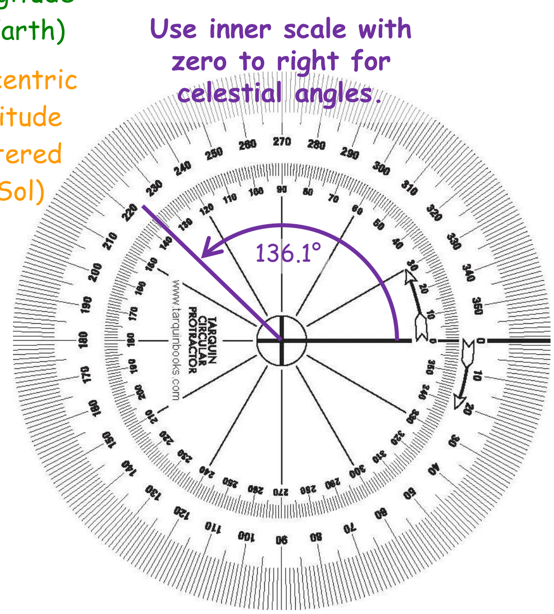
Kepler realized a couple important things about Mars. Its year is 687 days long. So every 687 days, Mars returns to the same place in its orbit. However, Earth will be in different positions every 687 days. Thus, we see Mars in a given position in its orbit from two different positions. Thus we can triangulate the position of Mars and, by that, plot its orbit.

On the following page are data that Kepler used. Each pair is dates 687 days apart. Thus, Mars is in the same position in its orbit for both observations, however, Earth is in two different positions in its orbit.

Date	Heliocentric Longitude of Earth	Geocentric Longitude of Mars
3/10/1585	179° 41′	131° 48′
1/26/1587	136° 06′	184° 42′

Note that Earth's position is given by it's heliocentric longitude, that is, its angle from the Vernal Equinox as measured eastward (counter clockwise) along its orbit centered on the sun. Mars appears in different positions in Earth's sky on the two dates even though it is in the same position in its orbit. The positions of Mars are given by its GEOCENTRIC longitude, also measured eastward (counterclockwise) from the Vernal Equinox, but centered on the Earth.



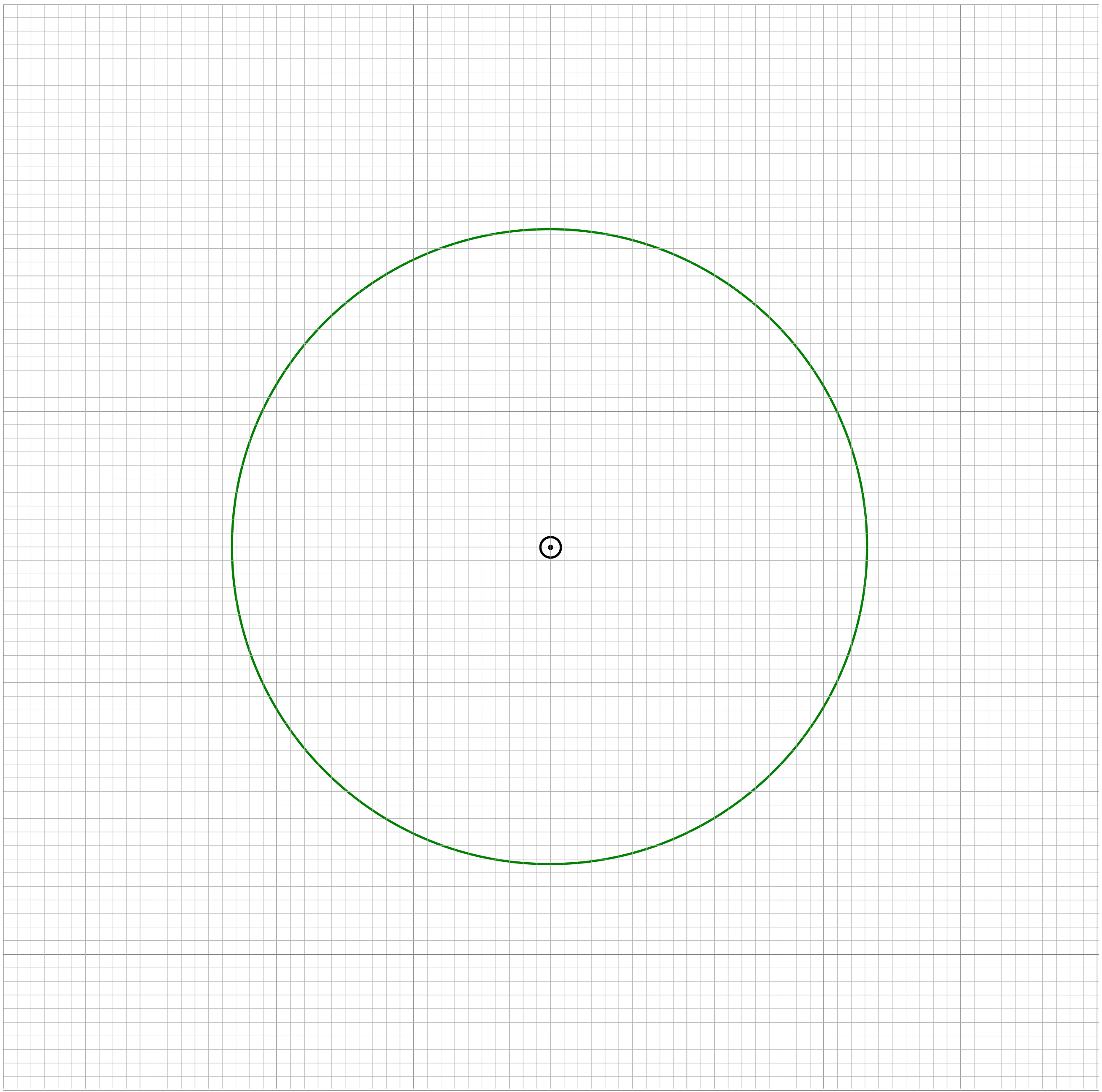


For each pair of data, you are to plot the position of Earth on its orbit for each date, then draw a line from that position to the geocentric position of Mars on that date. The point where the lines cross is the position of Mars on those dates. For the five pair of data (include the data above) you will thus get five positions on Mars' orbit.

The positions from the data in the left column are the perihelion and aphelion of Mars. Draw a line between these points, measure its length and mark the center point. Mars' "empty focus" is on that line opposite the sun at the same distance from the center as the sun. Mark this position. Put pushpins in both foci and place a loop of string around them adjusted so that it is tight with a pencil at either the aphelion or perihelion position. Keeping the string tight, draw the ellipse of Mars' orbit. It should pass through (or close to) all the positions you've plotted.

	Date	Heliocentric Longitude of Earth	Geocentric Longitude of Mars
Mars' Aphelion	2/17/1585	159° 23′	135° 12′
	1/5/1587	115° 21′	182° 08′
Mars' Perihelion	9/19/1591	5° 47′	284° 18′
	8/6/1583	323° 26′	346° 56′

Date	Heliocentric Longitude of Earth	Geocentric Longitude of Mars
12/7/1593	85° 53′	3° 04′
10/25/1595	41° 42′	49° 42′
3/28/1587	196° 50′	168° 12′
2/12/1589	153° 42′	218° 48′



Comment on how well your orbit fits the positions of Mars.