

Ptolemy's Fully Refined Lunar Model

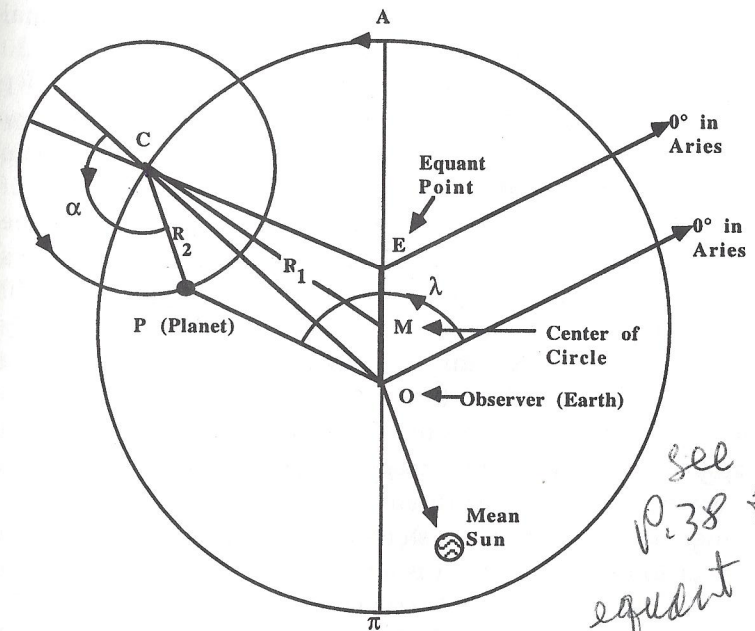
The epicycle center  $C$  moves at a constant rate in a counterclockwise direction around  $O$ . The point  $E$  moves in the opposite sense (i.e., clockwise) on the small circle about  $O$  (the earth), moving at a uniform rate with respect to the mean sun. This brings the epicycle gradually closer to  $O$  but then farther from it. The moon moves uniformly clockwise about the epicycle center  $C$ . Its mean anomaly  $\alpha$  is measured from the "mean apogee" of the epicycle  $A_m$ , which is the point on the epicycle farthest from  $E'$ , the point on the small circle diametrically opposite  $E$ .

It is interesting and important to ask whether Ptolemy believed his model for the moon's motion to be physically true. The preceding information, combined with the fact that Ptolemy set  $S$  equal to ca.  $10 \frac{1}{3}$ , makes it possible to answer that question. As noted in the discussion of Ptolemy's refined lunar model, the distance of the moon ranges from a maximum of  $R_1 + R_2$  to a minimum of  $R_1 - 2S - R_2$ . If the numerical values for these quantities are substituted for them, it is evident that the maximum value is  $60 + 5 \frac{1}{4} = 65 \frac{1}{4}$ , whereas the minimum is  $60 - 20 \frac{2}{3} - 5 \frac{1}{4} =$  about 34. This entails that the moon should at times appear nearly to double in size as it moves through its orbit. Ptolemy must have been aware that nothing of this kind happens; in fact, the angular width of the moon ranges between  $29'30''$  and  $33'36''$ . This suggests that Ptolemy viewed his lunar models as **computational devices**, rather than representations of the actual physical system. In other words, his eccentrics, epicycles, and deferents were seen by him as only

hypothetical constructs for use in computation. Some later authors attributed reality to these devices, but such was not Ptolemy's view. Nonetheless, Ptolemy seems to have been fully convinced of the truth of the view that the earth is the stationary center of the cosmos.

### Ptolemy's System: The Planets

The following diagram and discussion are focused primarily on Ptolemy's models for Mars, Jupiter, and Saturn. His models for Mercury and Venus are somewhat different and will not be treated in detail.



Ptolemy's Model for Mars, Jupiter, or Saturn

The epicycle's center  $C$  moves on the deferent of radius  $R_1$ , center  $M$ , and eccentricity from the earth ( $O$ ) of  $MO$ . The uniform motion of the epicycle center takes place, not with reference to  $M$  or to  $O$ , but with reference to the equant point,  $E$ , which lies on the apse line  $AEMO\pi$  at a distance from  $M$  equal to  $MO$ . The planet  $P$  moves on the epicycle of radius  $R_2$  in the same sense as that in which  $C$  moves about  $M$  and at such a rate

see p. 38 for equant point