

Rules for converting from heliocentric to geocentric

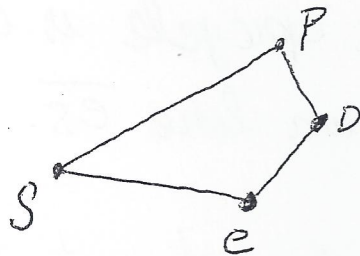
- ① Deferent radius = larger of $r_e, r_p \Rightarrow R_D$
- ② epicycle radius = smaller of $r_e, r_p \Rightarrow R_{epi}$

For an outer planet, $S = \text{sun}$

$e = \text{earth}$

$P = \text{planet}$

$D = \text{center of epicycle on Deferent circle}$



Draw a quadrilateral with vertices at S, e, D, P

here

$$\overline{SE} = r_e$$

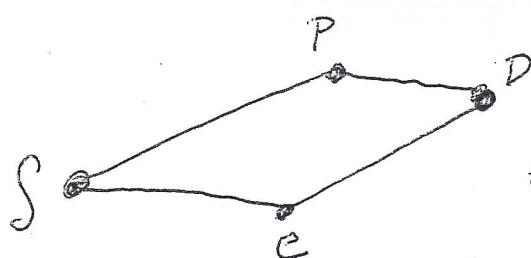
$$\overline{SP} = r_p$$

$$\overline{ED} = R_D$$

$$\overline{DP} = R_{epi}$$

From the rules ① & ② This requires the quadrilateral to be drawn with

$$\left. \begin{array}{l} R_D = r_p \Rightarrow \overline{SP} = \overline{ED} \\ r_e = R_{epi} \Rightarrow \overline{SE} = \overline{DP} \end{array} \right\} \Rightarrow \text{redraw quadrilateral}$$



This becomes a parallelogram
Hence Ptolemy required additional constraints:

Rules for Ptolemaic system

- ① R_D is the larger of r_e, r_p
- ② R_{epi} is the smaller of r_e, r_p

If the planet is an inner planet then

- ③ the center of the epicycle is colinear with the earth sun line \overline{es}

If the planet is an outer planet then

- ③ the line from the planet to the center of the epicycle, \overline{PD} , is parallel to the line from the sun to the earth, \overline{se}
or $\overline{se} \parallel \overline{PD}$

- ④ Retrograde motion occurs when a planet-earth-sun are in conjunction