

## Questions of “Projectability”

---

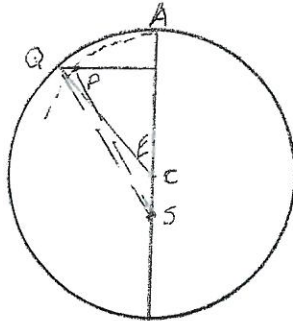
The evidence in *Astronomia Nova* shows that the four key claims – diametral distance rule, area rule, ellipse, and plane of fixed inclination through the true Sun – hold at least to high approximation for Mars over the course of its twelve revolutions of the zodiac between 1580 and 1604.

**Question:** What grounds could Kepler have offered for extrapolating – i.e. “*projecting*” – this result beyond that period of 24 years to the motion of Mars into the indefinite past and indefinite future?

**Question:** What grounds could Kepler have offered for extending – i.e. *projecting* – this result to the motions of Jupiter, Saturn, Venus and Mercury?

In other words, to what extent and on what grounds were the chief results of *Astronomia Nova* directly “projectable” – to use Nelson Goodman’s term – into broader “nomological” generalizations?

## Eccentric Circle vs. Ellipse, Both with Area Rule



< ASQ: heliocentric longitude, circle

< ASP: heliocentric longitude, ellipse

< E:	30 deg	45 deg	60 deg	75 deg	90 deg
<b>e=0.02</b>					
< ASQ	29.437	44.201	59.018	73.899	88.854
< ASP	29.432	44.195	59.013	73.896	88.854
diff	17.6 sec	20.7 sec	18.1 sec	11.1 sec	0.7 sec
<b>e=0.05</b>					
< ASQ	28.63	43.04	57.58	72.27	87.14
< ASP	28.60	43.01	57.55	72.25	87.13
diff	108.5 sec	128.8 sec	116.9 sec	74.9 sec	12.9 sec
<b>e=0.09</b>					
< ASQ	27.61	41.58	55.73	70.14	84.86
< ASP	27.51	41.46	55.63	70.01	84.84
diff	5.73 min	6.94 min	6.51 min	4.47 min	1.25 min

For purposes of comparison, the eccentricity of the Earth is a little less than 0.02; the eccentricity of Jupiter a little less and that of Saturn a little greater than 0.05; and the eccentricity of Mars a little greater than 0.09. In short, without Tycho's data, the distinction between circle and ellipse would not have been detectable, and even with it this difference was not detectable for Venus, Earth, Jupiter and Saturn.

Finally, a circle with equant and bisected eccentricity gives, for  $e=0.09$  and  $E=45$  deg, an angle  $ASP'$  of 41.36 deg and hence a difference between the angle  $ASP$  of the ellipse plus area rule of 5.84 min. So, asking astronomers before Tycho to have noticed the difference between a circle with bisected eccentricity and an equant and a Keplerian ellipse is asking for something they could not have done.