

parent revolution of the heaven of the fixed stars by the diurnal rotation of the earth round its axis; and by its annual movement round the sun he had afforded an equally perfect solution of the most striking movements of the planets (their stationary conditions and their retrogressions), and thus given the true reason of the so-called *second inequality of the planets*. The *first inequality*, or the unequal movement of the planets in their orbits, he left unexplained. True to the ancient Pythagorean principle of the perfectibility inherent in circular movements, Copernicus thought that he required for his structure of the universe some of the *epicycles* of Apollonius of Perga, besides the *eccentric* circles having a vacuum in their center. However bold was the path adventured on, the human mind could not at once emancipate itself from all earlier views.

The equal distance at which the stars remained, while the whole vault of heaven seemed to move from east to west, had led to the idea of a firmament and a solid crystal sphere, in which Anaximenes (who was probably not much later than Pythagoras) had conjectured that the stars were riveted like nails.* Geminus of Rhodes, the cotemporary of Cicero, doubted whether the constellations lay in one uniform plane, being of opinion that some were higher and others lower than the rest. The idea formed of the heaven of the fixed stars was extended to the planets, and thus arose the theory of the eccentric intercalated spheres of Eudoxus and Menæchmus, and of Aristotle, who was the inventor of *retrograde* spheres. The theory of epicycles—a construction which adapted itself most readily to the representation and calculation of the planetary movements—was, a century afterward, made by the acute mind of Apollonius to supersede solid spheres. However much I may incline to mere ideal abstraction, I here refrain from attempting to decide historically whether, as Ideler believes, it was not until after the establishment of the Alexandrian Museum that “a free movement of the planets in space was regarded as possible,” or whether, before that period, the intercalated transparent spheres (of which there were twenty-seven according to Eudoxus, and fifty-five according to Aristotle), as well as the epicycles which passed from Hipparchus and Ptolemy to the Middle Ages, were regarded generally not

* Plat., *De plac. Philos.*, ii., 14; Aristot., *Meteorol.*, xi., 8; *De Cælo*, ii., 8. On the theory of spheres generally, and on the retrograding spheres of Aristotle in particular, see Ideler's *Vorlesung. über Eudoxus*, 1828, s. 49-60.