

tal vault shattered by it in its fall. Kepler, from his considerations of comets which intersect the orbits of all the planets,* boasted, nearly two hundred and fifty years ago, that he had destroyed the seventy-seven concentric spheres of the celebrated Girolamo Fracastoro, as well as all the more ancient retrograde epicycles. The ideas entertained by such great thinkers as Eudoxus, Menæchmus, Aristotle, and Apollonius Pergæus, respecting the possible mechanism and motion of these solid, mutually intersecting spheres by which the planets were moved, and the question whether they regarded these systems of rings as mere ideal modes of representation, or intellectual fancies, by means of which difficult problems of the planetary orbits might be solved or determined approximately, are subjects of which I have already treated in another place,† and which are not devoid of interest in our endeavors to distinguish the different periods of development which have characterized the history of astronomy.

Before we pass from the very ancient, but artificial zodiacal grouping of the fixed stars, as regards their supposed insertion into solid spheres, to their natural and actual arrangement, and to the known laws of their relative distribution, it will be necessary more fully to consider some of the sensuous phenomena of the individual cosmical bodies—their extending rays, their apparent, spurious disk, and their differences of color. In the note referring to the invisibility of Jupiter's satellites,‡ I have already spoken of the influence of the so-called tails of the stars, which vary in number, position, and length in different individuals. Indistinctness of vision (*la vue indistincte*) arises from numerous organic causes, depending on aberration of the sphericity of

* Kepler expressly says, in his *Stella Martis*, fol. 9: "Solidos orbes rejeci." "I have rejected the idea of solid orbs;" and in the *Stella Nova*, 1606, cap. 2, p. 8: "Planetæ in puro æthere, perinde atque aves in aëre cursus suos conficiunt." "The planets perform their course in the pure ether as birds pass through the air." Compare also p. 122. He inclined, however, at an earlier period, to the idea of a solid icy vault of heaven congealed from the absence of solar heat: "Orbis ex aqua factus gelu concreta propter solis absentiam." (Kepler, *Epit. Astr. Copern.*, i., 2, p. 51.) "Two thousand years before Kepler, Empedocles maintained that the fixed stars were riveted to the crystal heavens, but that the planets were free and unrestrained" (τοὺς δε πλανήτας ἀνεῖσθαι). (Plut., *plac. Phil.*, ii., 13; Emped., 1, p. 335, Sturz; Euseb., *Præp. Evang.*, xv., 30, col. 1688, p. 839.) It is difficult to conceive how, according to Plato in the *Timæus* (*Tim.*, p. 40, B; see Bohn's edition of Plato, vol. ii., p. 344; but not according to Aristotle), the fixed stars, riveted as they are to solid spheres, could rotate independently.

† *Cosmos*, vol. ii., p. 315, 316.

‡ *Vide supra*, p. 51, and note.