

as solid bodies of material thickness, but merely as ideal abstractions. It is more certain that in the middle of the sixteenth century, when the theory of the seventy-seven homocentric spheres of the learned writer, Girolamo Fracastoro, found general approval; and when, at a later period, the opponents of Copernicus sought all means of upholding the Ptolemaic system, the idea of the existence of *solid* spheres, circles, and epicycles, which was especially favored by the Fathers of the Church, was still very widely diffused. Tycho Brahe expressly boasts that his considerations on the orbits of comets first proved the impossibility of solid spheres, and thus destroyed the artificial fabrics. He filled the free space of heaven with air, and even believed that the resisting medium, when disturbed by the revolving heavenly bodies, might generate tones. The unimaginative Rothmann believed it necessary to refute this renewed Pythagorean myth of celestial harmony.

Kepler's great discovery that all the planets move round the sun in ellipses, and that the sun lies in one of the foci of these ellipses, at length freed the original Copernican system from eccentric circles and all epicycles.* The planetary structure of the world now appeared objectively, and as it were architecturally, in its simple grandeur; but it remained for Isaac Newton to disclose the play and connection of the internal forces which animate and preserve the system of the universe. We have already often remarked, in the history of the gradual development of human knowledge, that important but apparently accidental discoveries, and the simultaneous appearance of many great minds, are crowded together in a short period of time; and we find this phenomenon most strikingly manifested in the first ten years of the seventeenth century; for Tycho Brahe (the founder of modern astronomical calculations), Kepler, Galileo, and Lord Bacon, were cotemporaries. All these, with the exception of Tycho Brahe, were enabled, in the prime of life, to benefit by the labors of Descartes and Fermat. The elements of Bacon's *Instauratio Magna* appeared in the English language in 1605, fifteen years before

* A better insight into the free movement of bodies, and into the independence of the direction once given to the earth's axis, and into the rotatory and progressive movement of the terrestrial planet in its orbit, has freed the original system of Copernicus from the assumption of a *declination movement*, or a so-called third movement of the earth (*De Revolut. Orb. Cæl.*, lib. i., cap. 11, *triplex motus telluris*). The parallelism of the earth's axis is maintained in the annual revolution round the sun, in conformity with the law of inertia, without the application of a *correcting* epicycle.