

ary nature of comets, and the deviation from the spherical form observed in the figure of the earth.\* Greek antiquity is also replete with uranological presentiments of this nature, which were realized in later times.

In the development of thought on cosmical relations, of which the main forms and epochs have been already enumerated, Kepler approached the nearest to a mathematical application of the theory of gravitation, more than seventy-eight years before the appearance of Newton's immortal work, *Principia Philosophiæ Naturalis*. For while the eclectic Simplicius only expressed in general terms "that the heavenly bodies were sustained from falling in consequence of the centrifugal force being superior to the inherent falling force of bodies and to the downward traction;" while Joannes Philoponus, a disciple of Ammonius Hermeas, ascribed the movement of the celestial bodies to "a primitive impulse, and the continued tendency to fall;" and while, as we have already observed, Copernicus defined only the general idea of gravitation, as it acts in the sun, as the center of the planetary world, in the earth and in the moon, using these memorable words, "Gravitatem non aliud esse quam appetentiam quandam naturalem partibus inditam a divina providentia opificis universorum, ut in unitatem integritatemque suam sese conferant, in formam globi coeuntes;" Kepler, in his introduction to the book *De Stella Martis*,† was the first who gave *numerical* calculations of the forces of attraction reciprocally exercised upon each other, according to their relative masses, by the earth and moon. He

\* Bartholmèss, tom. ii., p. 219, 232, 370. Bruno carefully collected all the separate observations made on the celestial phenomenon of the sudden appearance, in 1572, of a new star in Cassiopeia. Much discussion has been directed in modern times to the relation existing between Bruno, his two Calabrian fellow-countrymen, Bernardino Telesio and Thomas Campanella, and the platonic cardinal, Nicolaus Krebs of Cusa. See *Cosmos*, vol. ii., p. 310, 311, note.

† "Si duo lapides in aliquo loco Mundi collocarentur propinqui invicem, extra orbem virtutis tertii cognati corporis; illi lapides ad similitudinem duorum Magneticorum corporum coirent loco intermedio, quilibet accedens ad alterum tanto intervallo, quanta est alterius *moles* in comparatione. Si luna et terra non retinerentur vi animali (!) aut alia aliqua æquipollente, quælibet in suo circuitu, Terra adscenderet ad Lunam quinquagesima quarta parte intervalli, Luna descenderet ad Terram quinquaginta tribus circiter partibus intervalli; ibi jungerentur, posito tamen quod substantia utriusque sit unius et ejusdem densitatis." — Kepler, *Astronomia nova, seu Physica cælestis de Motibus Stellæ Martis*, 1609. *Introd.*, fol. v. On the older views regarding gravitation, see *Cosmos*, vol. ii., p. 310.