

of their mutual distances. Full of imagination, yet always proceeding with great caution, it was not till the year 1794, while distinguishing between optically and physically double stars, that he threw out his preliminary suggestions as to the nature of the relation of the larger star to its smaller companion. Nine years afterward, he first explained his views of the whole system of these phenomena, in the 93d volume of the *Philosophical Transactions*. The idea of partial star-systems, in which several suns revolve round a common center of gravity, was then firmly established. The stupendous influence of attractive forces, which in our solar system extends to Neptune, a distance 30 times that of the earth (or 2488 millions of geographical miles), and which compelled the great comet of 1680 to return in its orbit, at the distance of 28 of Neptune's semi-diameters (853 mean distances of the earth, or 70,800 millions of geographical miles), is also manifested in the motion of the double star 61 Cygni, which, with a parallax of  $0''\cdot3744$ , is distant from the sun 18,240 semi-diameters of Neptune's orbit (*i. e.*, 550,900 earth's mean distances, or 45,576,000 millions of geographical miles). But although Sir William Herschel so clearly discerned the causes and general connection of the phenomena, still, in the first few years of the nineteenth century, the angles of position derived from his own observations, owing to a want of due care in the use of the earlier catalogues, were confined to epochs too near together to admit of perfect certainty in determining the several numerical relations of the periodic times, or the elements of their orbits. Sir John Herschel himself alludes to the doubts regarding the accuracy of the assigned periods of revolution of  $\alpha$  Geminorum (334 years instead of 520, according to Mädler),\* of  $\gamma$  Virginis (708 instead of 169), and of  $\gamma$  Leonis (1424 of Struve's great catalogue), a splendid golden and reddish-green double star (1200 years).

After William Herschel, the elder Struve (from 1813 to 1842) and Sir John Herschel (from 1819 to 1838), availing themselves of the great improvements in astronomical instruments, and especially in micrometrical applications, have, with praiseworthy diligence, laid the proper and special foun-

\* Mädler, *ibid.*, th. i., s. 255. For Castor we have two old observations of Bradley, 1719 and 1759 (the former taken in conjunction with Pond, the latter with Maskelyne), and two of the elder Herschel, taken in the years 1779 and 1803. For the period of revolution of  $\gamma$  Virginis, see Mädler, *Fixstern-Syst.*, th. ii., s. 234-40, 1848.