

times; and the motion of the Node had been supposed uniform. He found that the inclination increased and diminished by twenty minutes, according to the position of the line of nodes; and that the nodes, though they regress upon the whole, sometimes go forwards and sometimes go backwards.

Tycho's discoveries concerning the moon are given in his *Progymnasmata*, which was published in 1603, two years after the author's death. He represents the Moon's motion in longitude by means of certain combinations of epicycles and eccentrics. But after Kepler had shown that such devices are to be banished from the planetary system, it was impossible not to think of extending the elliptical theory to the moon. Horrox succeeded in doing this; and in 1638 sent this essay to his friend Crabtree. It was published in 1673, with the numerical elements requisite for its application added by Flamsteed. Flamsteed had also (in 1671-2) compared this theory with observation, and found that it agreed far more nearly than the *Philolaic Tables* of Bullialdus, or the *Carolinian Tables* of Street (*Epilogus ad Tabulas*). Moreover Horrox, by making the centre of the ellipse revolve in an epicycle, gave an explanation of the evection, as well as of the equation of the centre.<sup>3</sup>

Modern astronomers, by calculating the effects of the perturbing forces of the solar system, and comparing their calculations with observation, have added many new corrections or equations to those known at the time of Horrox; and since the Motions of the heavenly bodies were even then affected by these variations as yet undetected, it is clear that the Tables of that time must have shown some errors when compared with observation. These errors much perplexed astronomers, and naturally gave rise to the question whether the motions of the heavenly bodies really were exactly regular, or whether they were not affected by accidents as little reducible to rule as wind and weather. Kepler had held the opinion of the *casualty* of such errors; but Horrox, far more philosophically, argues against this opinion, though he

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<sup>3</sup> Horrox (*Horrockes* as he himself spelt his name) gave a first sketch of his theory in letters to his friend Crabtree in 1638: in which the variation of the eccentricity is not alluded to. But in Crabtree's letter to Gascoigne in 1642, he gives Horrox's rule concerning it; and Flamsteed in his *Epilogue* to the Tables, published by Wallis along with Horrox's works in 1673, gave an explanation of the theory which made it amount very nearly to a revolution of the centre of the ellipse in an epicycle. Halley afterwards made a slight alteration; but hardly, I think, enough to justify Newton's assertion (*Princip. Lib. iii. Prop. 35, Schol.*), "Halleius centrum ellipseos in epicyclo locavit." See Baily's *Flamsteed*, p. 693.