

the smallness of the point of contact.<sup>3</sup> But the most common mistake of this period was, that of supposing that as force is requisite to move a body, so a perpetual supply of force is requisite to keep it in motion. The whole of what Kepler called his "physical" reasoning, depended upon this assumption. He endeavored to discover the forces by which the motions of the planets about the sun might be produced; but, in all cases, he considered the velocity of the planet as produced by, and exhibiting the effect of, a force which acted in the direction of the motion. Kepler's essays, which are in this respect so feeble and unmeaning, have sometimes been considered as disclosing some distant anticipation of Newton's discovery of the existence and law of central forces. There is, however, in reality, no other connection between these speculations than that which arises from the use of the term *force* by the two writers in two utterly different meanings. Kepler's Forces were certain imaginary qualities which appeared in the actual motion which the bodies had; Newton's Forces were causes which appeared by the change of motion: Kepler's Forces urged the bodies forwards; Newton's deflected the bodies from such a progress. If Kepler's Forces were destroyed, the body would instantly stop; if Newton's were annihilated, the body would go on uniformly in a straight line. Kepler compares the action of his Forces to the way in which a body might be driven round, by being placed among the sails of a windmill; Newton's Forces would be represented by a rope pulling the body to the centre. Newton's Force is merely mutual attraction; Kepler's is something quite different from this; for though he perpetually illustrates his views by the example of a magnet, he warns us that the sun differs from the magnet in this respect, that its force is not attractive, but directive.<sup>4</sup> Kepler's essays may with considerable reason be asserted to be an anticipation of the Vortices of Descartes; but they can with no propriety whatever be said to anticipate Newton's Dynamical Theory.

The confusion of thought which prevented mathematicians from seeing the difference between producing and preserving motion, was, indeed, fatal to all attempts at progress on this subject. We have already noticed the perplexity in which Aristotle involved himself, by his endeavors to find a reason for the continued motion of a stone

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<sup>3</sup> In speaking of the force which would draw a body up an inclined plane he observes, that "per communem animi sententiam," when the plane becomes horizontal, the requisite force is nothing.

<sup>4</sup> *Epitome Astron. Copern.* p. 176.