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**Miscellaneous Tracts on some curious, and very interesting Subjects in
Mechanics, Physical-Astronomy, and Speculative Mathematics ...**

Simpson, Thomas

London, 1757

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Preface.

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P R E F A C E.

THE TRACTS, or PAPERS composing the WORK here offered to the Publick, were drawn up at several, distant times, and upon different occasions; either, with a view to clear up, or settle some difficult or controverted point in Astronomy, to shew the conformity of Theory with Observations; or to extend and facilitate the analytic-method of computation, by some improvements and applications, that have not at all, or but slightly, been touched upon, at least by any English Author.

The first of these PAPERS, which is one of the most considerable in the whole work, is concerned in determining the Precession of the Equinox, and the various inequalities thereof, with the different motions of nutation of the Earth's Axis, arising from the attraction of the sun and moon; wherein the late important discovery of Dr. Bradley, relating to an apparent motion of the Fix'd Stars, unknown to former Astronomers, is shewn to be intirely consistent with the Theory of Gravitation. — This piece was drawn up about five years ago, in consequence of another on the same subject, by M. Silvabelle (a French Gentleman) then delivered to me, for my opinion, since printed in the Philosophical Transactions. — Tho' I have particular reasons for mentioning this circumstance, I would not be thought to insinuate here, that my opinion had any weight with Those to whom the publication of that paper was owing: I have, indeed, no reason to believe it. — Tho' the author thereof had gone through one part of the subject with success and perspicuity, and though his conclusions were found perfectly conformable to Dr. Bradley's observations, He nevertheless appeared (and still appears) to me: to have greatly failed in a very material, and indeed the only very difficult part, that is, in the determination of the momentary alteration of the position of the earth's axis, caused by the forces of the Sun and Moon; of which forces, the quantities, but not the effects, are truly investigated.

The Second Paper, contains the investigation of an easy, and very exact method, or rule, for finding the place of a Planet in its Orbit, from a correction of Dr. Ward's circular hypothesis; by means of certain Equations applied to the motion about the upper focus of the ellipsis. From whence that table of Dr. Halley's, entitled, Tabula pro expediendo calculo $\mathcal{A}$ equationis centri Lunæ, may be very readily constructed.

P R E F A C E.

structed.—By this method, the result, even in the orbit of Mercury, may be found within a second of the truth, without repeating the operation.

The Third, shews the manner of transferring the motion of a Comet from a parabolic, to an elliptic Orbit; being of great use, when the observed Places of a (new) Comet, are found to differ sensibly from those computed on the hypothesis of a parabolic orbit.

The Fourth, is an attempt to shew, from mathematical principles, the advantage arising by taking the mean of a number of observations, in practical Astronomy; wherein the odds that the result, this way, is more exact, than from one single observation, is evinced, and the utility of the method in practice, clearly made to appear.—A part of this, and of the 7th paper, is inserted in the XLIX volume of the Philosophical Transactions; but the farther improvements here added, will (I hope) be a sufficient apology for my printing the whole again, in this work.

The Fifth, contains the determination of certain Fluents, and the resolution of some very useful Equations, in the higher orders of fluxions, by means of the measures of angles and ratios, and the right sines, and versed sines of circular arcs.

The Sixth, treats of the resolution of algebraical equations, by the method of surd-divisors; wherein the grounds of that method, as laid down by Sir Isaac Newton, are investigated and explained.

The Seventh, exhibits the investigation of a general rule for the resolution of Isoperimetrical Problems of all orders, together with some examples of the use and application of the said rule.

The Eighth (and last) Part, comprehends the resolution of some general, and very interesting problems, in mechanics and physical Astronomy; wherein, among other particulars, the principal parts of the third, and ninth sections of the first Book of Sir Isaac Newton's Principia, are demonstrated, in a new, and very concise manner.—But what, I apprehend, may best recommend this part of the work, is the application of the general equations therein derived, to the determination of the lunar Orbit: In which I have exerted my utmost endeavours to render the whole intelligible even to Those who have arrived but to a tolerable proficiency in the higher geometry.

The greater part of what is here delivered on this subject, was drawn up in the year 1750, agreeably to what is intimated at the conclusion of my Doctrine of Fluxions, where the general equations are also given. The famous objection, about that time made to Sir Isaac Newton's general Law of Gravitation, by that eminent mathematician M. Clairaut,

P R E F A C E.

of the Royal Academy of Sciences at PARIS, was a motive sufficient to induce me (among many Others) to endeavour to discover, whether the motion of the moon's apogee, on which that objection had its whole weight and foundation, could not be truly accounted for, without supposing a change in the received law of gravitation, from the inverse ratio of the squares of the distances. The success was answerable to my hopes, and such as induced me to look farther into other parts of the theory of the moon's motion, than I first intended: but, before I had completed my design, I received the honour of a visit from M. Clairaut (just then arrived in England) of whom I learned, that he had a little before printed a piece on that subject; a copy of which I afterwards received, as a present at his hands; wherein I found most of the same things demonstrated, besides several others, to which I had not then extended my enquiry. Upon this, I at that time desisted from a farther prosecution of the subject; being chiefly diverted therefrom by a call then subsisting for a new edition of another work, in which some additions seemed wanting. But I cannot omit to observe here, in justice to M. Clairaut, that, tho' he indeed fell into a mistake, by too hastily inferring a defect in the received law of attraction, from the insufficiency of the known methods for determining the effect of that attraction, in the motion of the moon's apogee, yet he was himself, the first who discovered the true source, of that mistake, and who placed the matter in a proper light: Though there are some * who have, both before and since, undertaken to give the true quantity of that motion, from such principles, only, as are laid down in the ninth section of the first Book of the Principia: but that these Gentlemen, however they may have made their numbers to agree, have been greatly deceived in their calculations, is very certain; since a considerable part of the said motion depends on that part of the solar force acting in the direction perpendicular to the Radius-vector, which is by them, either intirely disregarded, or the effect thereof, not made one twentieth part of what it really ought to be.—There are Others indeed, who have explained the matter, upon true principles, and with better success. Since M. Clairaut's piece first made its appearance, the most eminent mathematicians, in different parts of Europe, have turned their thoughts that way. But tho' what I now offer on the same subject, may, perhaps, appear of less value, after what has been already done by these great men, yet I am not very solicitous upon that account, as it will be found, that I have neither copied from

* Vid. *Walmsley's Theorie du mouvement des apsides* (translated into English) and Vol. 47. N° 11. of the *Philosophical Transactions*. their

P R E F A C E.

their thoughts, nor detracted from their merit. The facility of the method I have fallen upon, will, I flatter myself, be allowed by all, who are appriz'd of the real difficulty of the subject; and the extensiveness thereof will, in some measure, appear from this, that it not only determines the motion of the apogee in the same manner, and with the same ease, as the other equations, but utterly excludes, at the same time, all terms of that dangerous species (if I may so express myself) that have hitherto embarrassed the greatest Mathematicians, and that would, after a great number of revolutions, intirely change the figure of the orbit. It thereby appears, that all the terms, or equations in general, will be expressed by sines and co-sines, barely, without any multiplication into the arcs corresponding. From whence this important consequence is derived, that the mean motion, and the greatest quantities of the several equations will remain unchanged; unless disturbed by the intervention of some foreign, or accidental cause.

In treating of this subject, as well as in most of the other parts of the ensuing work, I have chiefly adhered to the analytic method of Investigation, as being the most direct and extensive, and best adapted to these abstruse kinds of speculations. Where a geometrical demonstration could be introduced, and seemed preferable, I have given one: but, tho' a problem, sometimes, by this last method, acquires a degree of perspicuity and elegance, not easy to be arrived at any other way, yet I cannot be of the opinion of Those who affect to shew a dislike to every thing performed by means of symbols and an algebraical Process; since, so far is the synthetic method from having the advantage in all cases, that there are innumerable enquiries into nature, as well as in abstracted science, where it cannot be at all applied, to any purpose. Sir Isaac Newton himself (who perhaps extended it as far as any man could) has even in the most simple case of the lunar orbit (Princip. B. 3. prop. 28) been obliged to call in the assistance of algebra; which he has also done, in treating of the motion of bodies in resisting mediums, and in various other places. And it appears clear to me, that, it is by a diligent cultivation of the Modern Analysis, that Foreign Mathematicians have, of late, been able to push their Researches farther, in many particulars, than Sir Isaac Newton and his Followers here, have done: tho' it must be allowed, on the other hand, that the same Neatness, and Accuracy of Demonstration, is not every-where to be found in those Authors; owing in some measure, perhaps, to too great a disregard for the Geometry of the Antients.