A

PHILOSOPHICAL and MATHEMATICAL DICTIONARY.

K.

KALENDAR. See CALENDAR.

KALENDS. See CALENDS.

KEILL (Dr. JOHN), an eminent mathematician and philoſopher, was born at Edinburgh in 1671, and ſtudied in the univerſity of that city. His genius leading him to the mathematics, he made a great progreſs under David Gregory the profeſſor there, who was one of the firſt that had embraced and publicly taught the Newtonian philoſophy. In 1694 he followed his tutor to Oxford, where, being admitted of Baliol College, he obtained one of the Scotch exhibitions in that college. It is ſaid he was the firſt who taught Newton's principles by the experiments on which they are founded: and this it ſeems he did by an apparatus of inſtruments of his own providing; by which means he acquired a great reputation in the univerſity. The firſt public ſpecimen he gave of his ſkill in mathematical and philoſophical knowledge, was his *Examination of Dr. Burnet's Theory of the Earth; with Remarks on Mr. Whiſton's New Theory;* which appeared in 1698. Theſe theories were defended by their reſpective authors; which drew from him, in 1699, *An Examination of the Reflections on the Theory of the Earth,* together with *A Defence of the Remarks on Mr. Whiſton's New Theory.* Dr. Burnet was a man of great humanity, moderation, and candour; and it was therefore ſuppoſed that Keill had treated him too roughly, conſidering the great diſparity of years between them. Keill however left the doctor in poſſeſſion of that which has ſince been thought the great characteriſtic and excellence of his work; and though he diſclaimed him as a philoſopher, yet allowed him to be a man of a fine imagination. "Perhaps, ſays he, many of his readers will be ſorry to be undeceived about his theory; for, as I believe never any book was fuller of miſtakes and errors in philoſophy, ſo none ever abounded with more beautiful ſcenes and ſurpriſing images of nature. But I write only to thoſe who might expect to find a true philoſophy in it: they who read it as an ingenious romance, will ſtill be pleaſed with their entertainment."

The year following, Dr. Millington, Sedleian profeſſor of natural philoſophy in Oxford, who had been appointed phyſician to king William, ſubſtituted Keill as his deputy, to read the lectures in the public ſchool. This office he diſcharged with great reputation; and, the term of enjoying the Scotch exhibition at Baliol-college now expiring, he accepted an invitation from Dr. Aldrich, dean of Chriſt-church, to reſide there.

In 1701, he publiſhed his celebrated treatiſe, intitled, *Introductio ad Veram Phyſicam,* which is ſuppoſed to be the beſt and moſt uſeful of all his performances. The firſt edition of this book contained only fourteen lectures; but to the ſecond, in 1705, he added two more. This work was deſervedly eſteemed, both at home and abroad, as the beſt introduction to the Principia, or the new mechanical philoſophy, and was reprinted in different places; alſo a new edition in Engliſh was printed at London in 1736, at the inſtance of M. Maupertuis, who was then in England.

Being made Fellow of the Royal Society, he publiſhed, in the Philoſ. Tranſ. 1708, a paper on the Laws of Attraction, and its phyſical principles: and being offended at a paſſage in the *Acta Eruditorum* of Leipſic, where Newton's claim to the firſt invention of the method of Fluxions was called in queſtion, he warmly vindicated that claim againſt Leibnitz. In 1709 he went to New-England as treaſurer of the Palatines; and ſoon after his return in 1710, he was choſen Savilian profeſſor of aſtronomy at Oxford. In 1711, being attacked by Leibnitz, he entered the liſts with that mathematician, in the diſpute concerning the invention of Fluxions. Leibnitz wrote a letter to Dr. Hans Sloane, then ſecretary to the Royal Society, requiring Keill, in effect, to make him ſatisfaction for the injury he had done him in his paper relating to the paſſage in the *Acta Eruditorum*: he protoſted, that he was far from aſſuming to himſelf Newton's method of Fluxions; and therefore deſired that Keill might be obliged to retract his falſe aſſertion. On the other hand, Keill deſired that he might be permitted to juſtify what he had aſſerted. He made his defence to the approbation of Newton, and other members of the Society. A copy of this was ſent to Leibnitz; who, in a ſecond letter, remonſtrated ſtill more loudly againſt Keill's want of candour and ſincerity; adding, that it was not fit for one of his age and experience to engage in a diſpute with an upſtart, who acted without any authority from Newton, and deſiring that the Royal Society would enjoin him ſilence. Upon this, a ſpecial committee was appointed; who, after examining the facts, concluded their report with "reckoning Mr. Newton the inventor of Fluxions; and that Mr. Keill, in aſſerting the ſame, had been no ways injurious to Mr. Leibnitz." The whole proceedings upon this matter may be ſeen in Collins's *Commercium Epiſtolicum*, with many valuable papers of Newton, Leibnitz, Gregory, and other mathematicians. In the mean time Keill behaved himſelf with great firmneſs and ſpirit; which he alſo ſhewed afterwards in a Latin epiſtle, written in 1720, to Bernoulli, mathematical profeſſor at Baſil, on account of the ſame uſage ſhewn to Newton: in the title-page of which he put the arms of Scotland, viz, a Thiſtle, with this motto, *Nemo me impune laceſſit*.

About the year 1711, ſeveral objections being urged againſt Newton's philoſophy, in ſupport of Des Cartes's notions of a plenum, Keill publiſhed a paper in the Philoſ. Tranſ. on the Rarity of Matter, and the Tenuity of its Compoſition. But while he was engaged in this diſpute, queen Anne was pleaſed to appoint him her Decipherer; and he continued in that place under king George the Firſt till the year 1716. The univerſity of Oxford conferred on him the degree of M D. in 1713; and, two years after, he publiſhed an edition of Commandine's Euclid, with additions of his own. In 1718 he publiſhed his *Introductio ad Veram Aſtronomiam*: which was afterwards, at the requeſt of the ducheſs of Chandos, tranſlated by himſelf into Engliſh; and, with ſeveral emendations, publiſhed in 1721, under the title of *An Introduction to True Aſtronomy*, &c. This was his laſt gift to the public; being this ſummer ſeized with a violent fever, which terminated his life Sept. 1, in the 50th year of his age.

His papers in the Philoſ. Tranſ. above alluded to, are contained in volumes 26 and 29.

Keill (Dr. *James*), an eminent phyſician and philoſopher, and younger brother of Dr. John Keill above mentioned, was alſo born in Scotland, in 1673. Having travelled abroad, on his return he read lectures on Anatomy with great applauſe in the univerſities of Oxford and Cambridge, by the latter of which he had the degree of M. D. conferred upon him. In 1703 he ſettled at Northampton as a phyſician, where he died of a cancer in the mouth in 1719. His publications are

1. An Engliſh tranſlation of Lemery's Chemiſtry.
2. On Animal Secretion, the quantity of Blood in the Human Body, and on Muſcular Motion.
3. A treatiſe on Anatomy.
4. Several pieces in the Philoſ. Tranſ. volumes 25 and 30.

KEPLER (John), a very eminent aſtronomer and mathematician, was born at Wiel, in the county of Wirtemberg, in 1571. He was the diſciple of Mæſtlinus, a learned mathematician and aſtronomer, of whom he learned thoſe ſciences, and became afterwards profeſſor of them to three ſucceſſive emperors, viz. Matthias, Rudolphus, and Ferdinand the 2d.

To this ſagacious philoſopher we owe the firſt diſcovery of the great laws of the planetary motions, viz. that the planets deſcribe areas that are always proportional to the times; that they move in elliptical orbits, having the ſun in one focus; and that the ſquares of their periodic times, are proportional to the cubes of their mean diſtances; which are now generally known by the name of Kepler's Laws. But as this great man ſtands as it were at the head of the modern reformed aſtronomy, he is highly deſerving of a pretty large account, which we ſhall extract chiefly from the words of that great mathematician Mr. Maclaurin.

Kepler had a particular paſſion for finding analogies and harmonies in nature, after the manner of the Pythagoreans and Platoniſts; and to this diſpoſition we owe ſuch valuable diſcoveries, as are more than ſufficient to excuſe his conceits. Three things, he tells us, he anxiouſly fought to find out the reaſon of, from his early youth; viz, Why the planets were 6 in number? Why the dimenſions of their orbits were ſuch as Copernicus had deſcribed from obſervations? And what was the analogy or law of their revolutions? He ſought for the reaſons of the two firſt of theſe, in the properties of numbers and plane figures, without ſucceſs. But at length reflecting, that while the plane regular figures may be infinite in number, the regular ſolids are only five, as Euclid had long ago demonſtrated: he imagined, that certain myſteries in nature might correſpond with this remarkable limitation inherent in the eſſences of things; and the rather, as he found that the Pythagoreans had made great uſe of thoſe five regular ſolids in their philoſophy. He therefore endeavoured to find ſome relation between the dimenſions of theſe ſolids and the intervals of the planetary ſpheres; thus, imagining that a cube, inſcribed in the ſphere of Saturn, would touch by its ſix planes the ſphere of Jupiter; and that the other four regular ſolids in like manner fitted the intervals that are between the ſpheres of the other planets: he became perſuaded that this was the true reaſon why the primary planets were preciſely ſix in number, and that the author of the world had determined their diſtances from the ſun, the centre of the ſyſtem, from a regard to this analogy. Being thus poſſeſſed, as he thought, of the grand ſecret of the Pythagoreans, and greatly pleaſed with his diſcovery, he publiſhed it in 1596, under the title of *Myſterium Coſmographicum*; and was for ſome time ſo charmed with it, that he ſaid he he would not give up the honour of having invented what was contained in that book, for the electorate of Saxony.

Kepler sent a copy of this book to Tycho Brahe, who did not approve of those abstract speculations concerning the system of the world, but wrote to Kepler, first to lay a solid foundation in observations, and then, by ascending from them, to endeavour to come at the causes of things. Tycho however, pleased with his genius, was very desirous of having Kepler with him to assist him in his labours: and having settled, under the protection of the emperor, in Bohemia, where he passed the last years of his life, after having left his native country on some ill usage, he prevailed upon Kepler to leave the university of Gratz, and remove into Bohemia, with his family and library, in the year 1600. But Tycho dying the next year, the arranging the observations devolved upon Kepler, and from that time he had the title of Mathematician to the Emperor all his life, and gained continually more and more reputation by his works. The emperor Rudolph ordered him to finish the tables of Tycho Brahe, which were to be called the *Rudolphine Tables*. Kepler applied diligently to the work: but unhappy are those learned men who depend upon the good-humour of the intendants of the finances; the treasurers were so ill-affected towards our author, that he could not publish these tables till 1627. He died at Ratisbon, in 1630, where he was soliciting the payment of the arrears of his pension.

Kepler made many important discoveries from Tycho's observations, as well as his own. He found, that astronomers had erred, from the first rise of the science, in ascribing always circular orbits and uniform motions to the planets; that, on the contrary, each of them moves in an ellipsis which has one of its foci in the sun: that the motion of each is really unequable, and varies so, that a ray supposed to be always drawn from the planet to the sun describes equal areas in equal times.

It was some years later before he discovered the analogy there is between the distances of the several planets from the sun, and the periods in which they complete their revolutions. He easily saw, that the higher planets not only moved in greater circles, but also more slowly than the nearer ones; so that, on a double account, their periodic times were greater. Saturn, for example, revolves at the distance from the sun $9\frac{1}{2}$ times greater than the earth's distance from it; and the circle described by Saturn is in the same proportion: but as the earth revolves in one year, so, if their velocities were equal, Saturn ought to revolve in 9 years and a half; whereas the periodic time of Saturn is about 29 years. The periodic times of the planets increase, therefore, in a greater proportion than their distances from the sun: but yet not in so great a proportion as the squares of those distances; for if that were the law of the motions, (the square of $9\frac{1}{2}$ being $90\frac{1}{4}$), the periodic time of Saturn ought to be above 90 years. A mean proportion between that of the distances of the planets, and that of the squares of those distances, is the true proportion of the periodic times; as the mean between $9\frac{1}{2}$ and its square $90\frac{1}{4}$, gives the periodic time of Saturn in years. Kepler, after having committed several mistakes in determining this analogy, hit upon it at last, May the 15, 1618; for he is so particular as to mention the precise day when he found that "The squares of the periodic times were always in the same proportion as the cubes of their mean distances from the sun."

When Kepler saw, according to better observations, that his disposition of the five regular solids among the planetary spheres, was not agreeable to the intervals between their orbits, he endeavoured to discover other schemes of harmony. For this purpose, he compared the motions of the same planet at its greatest and least distances, and of the different planets in their several orbits, as they would appear viewed from the sun; and here he fancied that he found a similitude to the divisions of the octave in music. These were the dreams of this ingenious man, which he was so fond of, that, hearing of the discovery of four new planets (the satellites of Jupiter) by Galileo, he owns that his first reflections were from a concern how he could save his favourite scheme, which was threatened by this addition to the number of the planets. The same attachment led him into a wrong judgment concerning the sphere of the fixed stars: for being obliged, by his doctrine, to allow a vast superiority to the sun in the universe, he restrains the fixed stars within very narrow limits. Nor did he consider them as suns, placed in the centres of their several systems, having planets revolving round them; as the other followers of Copernicus have concluded them to be, from their having light in themselves, from their immense distances, and from the analogy of nature. Not contented with these harmonies, which he had learned from the observations of Tycho, he gave himself the liberty to imagine several other analogies, that have no foundation in nature, and are overthrown by the best observations. Thus from the opinions of Kepler, though most justly admired, we are taught the danger of espousing principles, or hypotheses, borrowed from abstract sciences, and of applying them, with such freedom, to natural enquiries.

A more recent instance of this fondness, for discovering analogies between matters of abstract speculation, and the constitution of nature, we find in Huygens, one of the greatest geometricians and astronomers any age has produced: when he had discovered that satellite of Saturn, which from him is still called the Huygenian satellite, this, with our moon, and the four satellites of Jupiter, completed the number of six secondary planets then discovered in the system; and because the number of primary planets was also six, and this number is called by mathematicians a perfect number (being equal to the sum of its aliquot parts, 1, 2, 3,) Huygens was hence induced to believe that the number of the planets was complete, and that it was in vain to look for any more. This is not mentioned to lessen the credit of this great man, who never perhaps reasoned in such a manner on any other occasion; but only to shew, by another instance, how ill-grounded reasonings of this kind have always proved. For, not long after, the celebrated Cassini discovered four more satellites about Saturn, not to mention the two more that have lately been discovered to that planet by Dr. Herschel, with another new primary planet and its two satellites, besides many others, of both sorts, as yet unknown, which possibly may belong to our system. The same Cassini having found that the analogy, discovered by Kepler, between the periodic times and the distances from the centre, takes place in the leſſer ſyſtems of Jupiter and Saturn, as well as in the great ſolar ſyſtem; his obſervations overturned that groundleſs analogy which had been imagined between the number of the planets, both primary and ſecondary, and the number ſix: but eſtabliſhed, at the ſame time, that harmony in their motions, which will afterwards appear to flow from one real principle extended over the univerſe.

But to return to Kepler; his great ſagacity, and continual meditations on the planetary motions, ſuggeſted to him ſome views of the true principles from which theſe motions flow. In his preface to the Commentaries concerning the planet Mars, he ſpeaks of gravity as of a power that was mutual between bodies, and tells us, that the earth and moon tend towards each other, and would meet in a point, ſo many times nearer to the earth than to the moon, as the earth is greater than the moon, if their motions did not hinder it. He adds, that the tides ariſe from the gravity of the waters towards the moon. But not having notions ſufficiently juſt of the laws of motion, it ſeems he was not able to make the beſt uſe of theſe thoughts; nor does it appear that he adhered to them ſteadily, ſince in his Epitome of Aſtronomy, publiſhed many years after, he propoſes a phyſical account of the planetary motions, derived from different principles.

He ſuppoſes, in that treatiſe, that the motion of the ſun on his axis, is preſerved by ſome inherent vital principle; that a certain virtue, or immaterial image of the ſun, is diffuſed with his rays into the ambient ſpaces, and, revolving with the body of the ſun on his axis, takes hold of the planets, and carries them along with it in the ſame direction; like as a loadſtone turned round near a magnetic needle, makes it turn round at the ſame time. The planet, according to him, by its inertia, endeavours to continue in its place, and the action of the ſun's image and this inertia are in a perpetual ſtruggle. He adds, that this action of the ſun, like his light, decreaſes as the diſtance increaſes; and therefore moves the ſame planet with greater celerity when nearer the ſun, than at a greater diſtance. To account for the planet's approaching towards the ſun as it deſcends from the aphelion to the perihelion, and receding from the ſun while it aſcends to the aphelion again, he ſuppoſes that the ſun attracts one part of each planet, and repels the oppoſite part; and that the part attracted is turned towards the ſun in the deſcent, and the other towards the ſun in the aſcent. By ſuppoſitions of this kind, he endeavoured to account for all the other varieties of the celeſtial motions.

But, now that the laws of motion are better known than in Kepler's time, it is eaſy to ſhew the fallacy of every part of this account of the planetary motions. The planet does not endeavour to ſtop in conſequence of its inertia, but to perſevere in its motion in a right line. An attractive force makes it deſcend from the aphelion to the perihelion in a curve concave towards the ſun: but the repelling force, which he ſuppoſed to begin at the perihelion, would cauſe it to aſcend in a figure convex towards the ſun. There will be occaſion to ſhew afterwards, from Sir Iſaac Newton, how an attraction or gravitation towards the ſun, alone produces the effects, which, according to Kepler, required both an attractive and repelling force; and that the virtue which he aſcribed to the ſun's image, propagated into the planetary regions, is unneceſſary, as it could be of no uſe for this effect, though it were admitted. For now his own prophecy, with which he concludes his book, is verified; where he tells us, that "the diſcovery of ſuch things was reſerved for the ſucceeding ages, when the author of nature would be pleaſed to reveal theſe myſteries."

The works of this celebrated author are many and valuable; as,

1. His *Coſmographical Myſtery*, in 1596.
2. *Optical Aſtronomy*, in 1604.
3. *Account of a New Star in Sagittarius*, 1605.
4. *New Aſtronomy; or, Celeſtial Phyſics*, in Commentaries on the planet Mars.
5. *Diſſertations;* with the *Nuncius Siderius* of Galileo, 1610.
6. *New Gauging of Wine Caſks*, 1615. Said to be written on occaſion of an erroneous meaſurement of the wine at his marriage by the revenue officer.
7. *New Ephemerides*, from 1617 to 1620.
8. *Copernican Syſtem*, three firſt books of the, 1618.
9. *Harmony of the World;* and three books of *Comets*, 1619.
10. *Coſmographical Myſtery*, 2d edit. with Notes, 1621.
11. *Copernican Aſtronomy*; the three laſt books, 1622.
12. *Logarithms*, 1624; and the *Supplement*, in 1625.
13. His *Aſtronomical Tables*, called the *Rudolphine Tables*, in honour of the emperor Rudolphus, his great and learned patron, in 1627.
14. *Epitome of the Copernican Aſtronomy*, 1635.

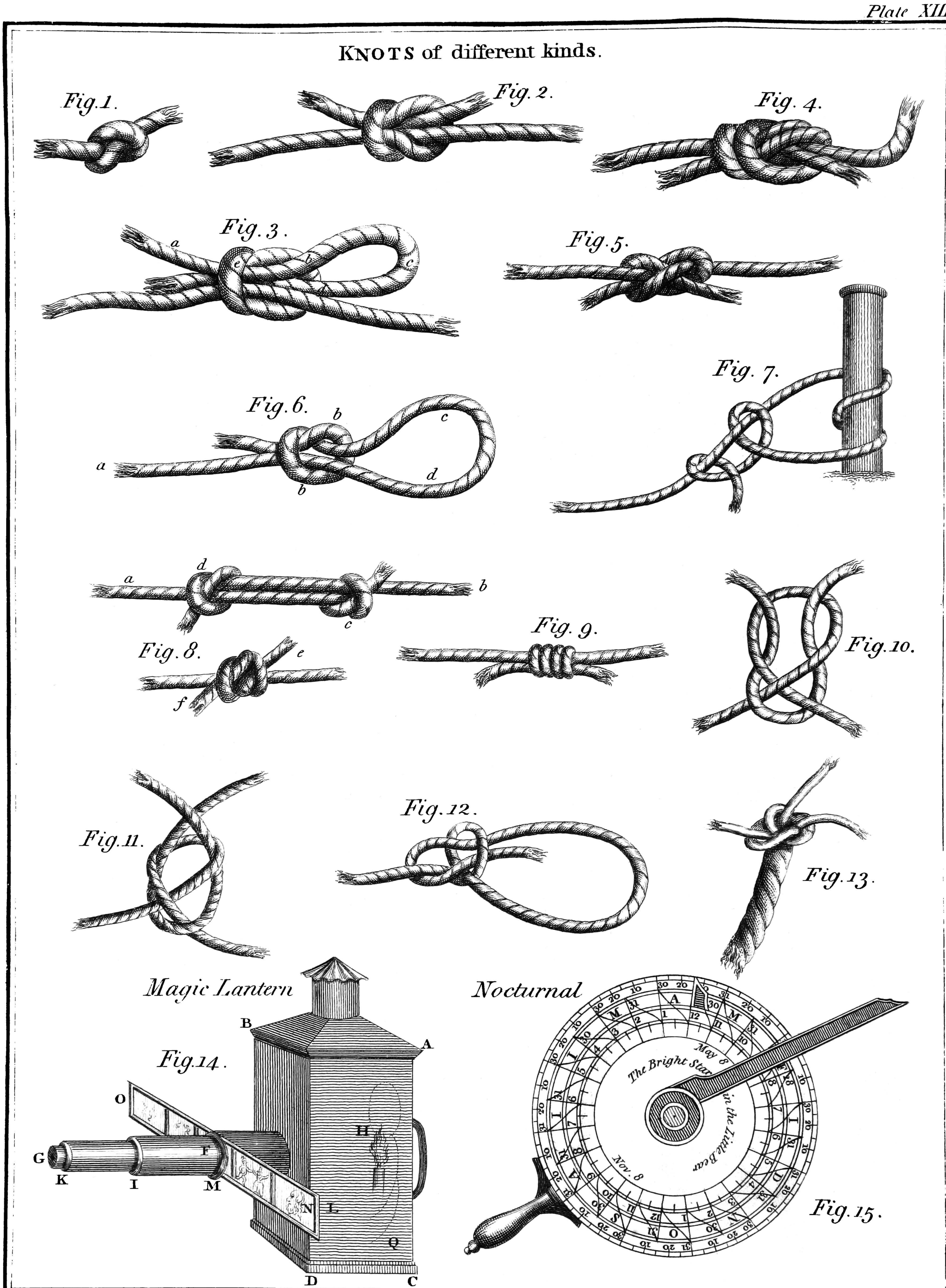
Beſide theſe, he wrote ſeveral pieces on various other branches, as *Chronology*, *Geometry of Solids*, *Trigonometry*, and an excellent treatiſe of *Dioptrics*, for that time.

KEPLER'S LAWS, are thoſe laws of the planetary motions diſcovered by Kepler. Theſe diſcoveries in the mundane ſyſtem, are commonly accounted two, viz. 1ſt, That the planets deſcribe about the ſun, areas that are proportional to the times in which they are deſcribed, namely, by a line connecting the ſun and planet; and 2d, That the ſquares of the times of revolution, are as the cubes of the mean diſtances of the planets from the ſun. Kepler diſcovered alſo that the orbits of the planets are elliptical.

Theſe diſcoveries of Kepler, however, were only found out by many trials, in ſearching among a great number of aſtronomical obſervations and revolutions, what rules and laws were found to obtain. On the other hand, Newton has demonſtrated, *a priori*, all theſe laws, ſhewing that they muſt obtain in the mundane ſyſtem, from the laws of gravitation and centripetal force; viz, the firſt of theſe laws reſulting from a centripetal force urging the planets towards the ſun, and the 2d, from the centripetal force being in an inverſe ratio of the ſquare of the diſtance. And the elliptic form of the orbits, from a projectile force regulated by a centripetal one.

KEPLER'S *Problem*, is the determining the true from the mean anomaly of a planet, or the determining its place, in its elliptic orbit, anſwering to any given time; and ſo named from the celebrated aſtronomer Kepler, who firſt propoſed it. See ANOMALY.

 The


KNOTS of different kinds.
Fig. 1.
Fig. 2.
Fig. 4.
Fig. 3.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.
Magic Lantern
Fig. 14.
Nocturnal
Fig. 15.
The Bright Star
in the Little Bear
May 8
Nov. 8

The general ſtate of the problem is this: To find the poſition of a right line, which, paſſing through one of the foci of an ellipſis, ſhall cut off an area which ſhall be in any given proportion to the whole area of the ellipſis; which reſults from this property, that ſuch a line ſweeps areas that are proportional to the times.

Many ſolutions have been given of this problem, ſome direct and geometrical, others not: viz, by Kepler, Bulliald, Ward, Newton, Keill, Machin, &c. See Newton's Princip. lib. 1. prop. 31, Keill's Aſtron. Lect. 23, Philoſ Tranſ abr. vol. 8. pa. 73, &c.

In the laſt of theſe place , Mr. Machin obſerves, that many attempts have been made at different times, but with no great ſucceſs, towards the ſolution of the problem propoſed by Kepler: To divide the area of a ſemicircle into given parts, by a line drawn from a given point in the diameter, in order to find an univerſal rule for the motion of a body in an elliptic orbit. For among the ſeveral methods offered, ſome are only true in ſpeculation, but are really of no ſervice; others are not different from his own, which he judged improper. And as to the reſt, they are all ſo limited and confined to particular conditions and circumſtances, as ſtill to leave the problem in general untouched. To be more particular; it is evident, that all conſtructions by mechanical curves are ſeeming ſolutions only, but in reality unapplicable; that the roots of infinite ſeries are, on account of their known limitations in all reſpects, ſo far from being ſufficient rules, that they ſerve for little more than exerciſes in a method of calculation. And then, as to the univerſal method, which proceeds by a continued correction of the errors of a falſe poſition, it is no method of ſolution at all in itſelf; becauſe, unleſs there be ſome antecedent rule or hypotheſis to begin the operation (as ſuppoſe that of an uniform motion about the upper focus, for the orbit of a planet; or that of a motion in a parabola for the perihelion part of the orbit of a comet, or ſome other ſuch), it would be impoſſible to proceed one ſtep in it. But as no general rule has ever yet been laid down, to aſſiſt this method, ſo as to make it always operate, it is the ſame in effect as if there were no method at all. And accordingly in experience it is found, that there is no rule now ſubſiſting but what is abſolutely uſeleſs in the elliptic orbits of comets; for in ſuch caſes there is no other way to proceed but that which was uſed by Kepler: to compute a table for ſome part of the orbit, and in it examine if the time to which the place is required, will fall out any where in that part. So that, upon the whole, it appears evident, that this problem, contrary to the received opinion, has never yet been advanced one ſtep towards its true ſolution.

Mr. Machin then proceeds to give his own ſolution of this problem, which is particularly neceſſary in orbits of a great excentricity; and he illuſtrates his method by examples for the orbits of Venus, of Mercury, of the comet of the year 1682, and of the great comet of the year 1680, ſufficiently ſhewing the univerſality of the method.

KEY, in Muſic, is a certain fundamental note, or tone, to which the whole piece, be it concerto, ſonata, cantata, &c, is accommodated; and with which it uſually begins, but always ends.

Keys denote alſo, in an organ, harpſichord, &c, the pieces of wood or ivory which are ſtruck by the fingers, in playing upon the inſtrument.

Keystone, the middle vouſſoir, or the arch ſtone in the top, or immediately over the centre of an arch — The length of the keyſtone, or thickneſs of the archivolt at top, is allowed by the beſt architects, to be about the 15th or 16th part of the ſpan.

KILDERKIN, a kind of liquid meaſure, containing two firkins, or 18 gallons, beer-meaſure, or 16 ale-meaſure.

KING-*piece*, or King-*poſt*, is a piece of timber ſet upright in the middle, between two principal rafters, and having ſtruts or braces going from it to the middle of each rafter.

KIRCH (Christian Frederic), of Berlin, a celebrated aſtronomer, was born at Guben in 1694. He acquired great reputation in the obſervatories of Dantzic and Berlin. Godfrey Kirch his father, and Mary his mother, alſo acquired conſiderable reputation by their aſtronomical obſervations. This family correſponded with all the learned ſocieties of Europe, and their aſtronomical works are in great repute.

KIRCHER (Athanasius), a famous philoſopher and mathematician, was born at Fulde in 1601. He entered into the ſociety of the Jeſuits in 1618, and taught philoſophy, mathematics, the Hebrew and Syriac Languages, in the univerſity of Wirtſburg, with great applauſe, till the year 1631. He retired to France on account of the ravages committed by the Swedes in Franconia, and lived ſome time at Avignon. He was afterwards called to Rome, where he taught mathematics in the Roman college, collected a rich cabinet of machines and antiquities, and died in 1680, in the 80th year of his age.

The quantity of his works is immenſe, amounting to 22 volumes in folio, 11 in quarto, and three in octavo; enough to employ a man for a great part of his life even to tranſcribe them. Moſt of them are rather curious than uſeful; many of them viſionary and fanciful; and it is not to be wondered at, if they are not always accompanied with the greateſt exactneſs and preciſion. The principal of them are,

1. *Præluſiones Magneticæ.*
2. *Primitiæ Gnomonicæ Catoptricæ.*
3. *Ars magna Lucis et Umbræ.*
4. *Muſurgia Univerſalis.*
5. *Obeliſcus Pamphilius.*
6. *Oedipus Ægyptiacus*; 4 volumes folio.
7. *Itinerarium Extaticum.*
8. *Obeliſcus Ægyptiacus*; 4 volumes folio.
9. *Mundus Subterraneus.*
10. *China Illuſtrata.*

KNOT, a tye, or complication of a rope, cord, or ſtring, or of the ends of two together. There are divers ſorts of knots uſed for different purpoſes, which may be explained by ſhewing the figures of them open, or undrawn, thus. 1. Fig. 1, plate xiii. is a *Thumb knot*. This is the ſimpleſt of all. It is uſed to tye at the end of a rope, to prevent its opening out: it is alſo uſed by taylors &c. at the end of their thread.

Fig. 2, a *Loop knot*. Uſed to join pieces of rope &c. together.

Fig. 3, a *Draw knot*, which is the ſame as the laſt; only one end or both return the ſame way back, as

a b c d.

a b c d. By drawing at *a*, the part *b c d* comes through, and the knot is loofed.

Fig. 4, a *Ring knot*. This ferves alfo to join pieces of cord &c together.

Fig. 5 is another knot for tying cords together. This is ufed when any cord is often to be loofed.

Fig. 6, a *Running knot*, to draw any thing clofe. By pulling at the end *a*, the cord is drawn through the loop *b*, and the part *c d* is drawn clofe about a beam, &c.

Fig. 7 is another knot, to tye any thing to a poft. And here the end may be put through as often as you pleafe.

Fig. 8, a *Very fmall knot*. A thumb knot is firft made at the end of each piece, and then the end of the other is paffed through it. Thus, the cord *a c* runs through the loop *d*, and *b d* through *c*; and then drawn clofe by pulling at *a* and *b*. If the ends *e* and *f* be drawn, the knot will be loofed again.

Fig. 9, a *Fifher's knot*, or *Water knot*. This is the fame as the 4th, only the ends are to be put twice through the ring, which in the former was but once; and then drawn clofe.

Fig. 10, a *Mefhing knot*, for nets; and is to be drawn clofe.

Fig. 11, a *Barber's knot*, or a knot for cawls of wigs; and is to be drawn clofe.

Fig. 12, a *Bowline knot*. When this is drawn clofe, it makes a loop that will not flip, as fig. 7; and ferves to hitch over any thing.

Fig. 13, a *Wale knot*, which is made with the three ftrands of a rope, fo that it cannot flip. When the rope is put through a hole, this knot keeps it from flipping through. When the three ftrands are wrought round once or twice more, after the fame manner, it is called *crowning*. By this means the knot is made larger and ftronger. A thumb knot, N°. 1, may be applied to the fame ufe as this.

KNOTS mean alfo the divifions of the log line, ufed at fea. Thefe are ufually 7 fathom, or 42 feet afunder; but fhould be $8\frac{1}{3}$ fathom, or 50 feet. And then, as many knots as the log line runs out in half a minute, fo many miles does the fhip fail in an hour; fuppofing her to keep going at an equal rate, and allowing for yaws, leeway, &c.

KOENIG (SAMUEL), a learned philofopher and mathematician, was a Swifs by birth, and came early into eminence by his mathematical abilities. He was profeffor of philofophy and natural law at Franeker, and afterwards at the Hague, where he became alfo librarian to the Stadtholder, and to the Princefs of Orange; and where he died in 1757.

The Academy of Berlin enrolled him among her members; but afterwards expelled him on the following occafion. Maupertuis, the prefident, had inferted in the volume of the Memoirs for 1746, a difcourfe upon the Laws of Motion; which Koenig not only attacked, but alfo attributed the memoir to Leibnitz. Maupertuis, ftung with the imputation of plagiarifm, engaged the Academy of Berlin to call upon him for his proof; which Koenig failing to produce, he was ftruck out of the academy. All Europe was interefted in the quarrel which this occafioned between Koenig and Maupertuis. The former appealed to the public; and his appeal, written with the animation of refentment, procured him many friends. He was author of fome other works, and had the character of being one of the beft mathematicians of the age.

L.

LABEL, a long thin brafs ruler, with a fmall fight at one end, and a central hole at the other; commonly ufed with a tangent-line on the edge of a circumferentor, to take altitudes, and other angles.

LACERTA, *Lizard*, one of the new conftellations of the northern hemifphere, added by Hevelius to the 48 old ones, near Cepheus and Caffiopeia.

This conftellation contains, in Hevelius's catalogue 10 ftars, and in Flamfteed's 16.

LACUNAR, an arched roof or cieling; more efpecially the planking or flooring above the porticos.

LADY-*Day* the 25th of March, being the Annanciation of the Holy Virgin.

LAGNY (THOMAS FANTET *de*), an eminent French mathematician, was born at Lyons. Fournier's Euclid, and Pelletier's Algebra, by chance falling in his way, developed his genius for the mathematics. It was in vain that his father defigned him for the law; he went to Paris to deliver himfelf wholly up to the ftudy of his favourite fcience. In 1697, the Abbé Bignon, protector-general of letters, got him appointed profeffor-royal of Hydrography at Rochfort. Soon after, the duke of Orleans, then regent of France, fixed him at Paris, and made him fub-director of the General Bank, in which he loft the greateft part of his fortune in the failure of the Bank He had been received into the ancient academy in 1696; upon the renewal of which he was named Affociate-geometrician in 1699, and penfioner in 1723. After a life fpent in clofe application, he died, April 12, 1734.

In the laft moments of his life, and when he had loft all knowledge of the perfons who furrounded his

8 bed,

bed, one of them, through curiofity, afked him, what is the fquare of 12? To which he immediately replied, and without feeming to know that he gave any anfwer, 144.

De Lagny particularly excelled in arithmetic, algebra, and geometry in which he made many improvements and difcoveries. He, as well as Leibnitz, invented a binary arithmetic, in which only two figures are concerned. He rendered much eafier the refolution of algebraic equations, efpecially the irreducible cafe in cubic equations; and the numeral refolution of the higher powers, by means of fhort approximating theorems.—He delivered the meafures of angles in a new fcience, called *Goniometry*; in which he meafured angles by a pair of compaffes, without fcales, or tables, to great exactnefs; and thus gave a new appearance to trigonometry.—*Cyclometry*, or the meafure of the circle, was alfo an object of his attention; and he calculated, by means of infinite feries, the ratio of the circumference of a circle to its diameter, to 120 places of figures.—He gave a general theorem for the tangents of multiple arcs. With many other curious or ufeful improvements, which are found in the great multitude of his papers, that are printed in the different volumes of the Memoirs of the Academy of Sciences, viz, in almoft every volume, from the year 1699, to 1729.

LAKE, a collection of water, inclofed in the cavity of fome inland place, of a confiderable extent and depth. As the Lake of Geneva, &c.

LAMMAS-DAY, the 1ft of Auguft; fo called, according to fome, becaufe lambs then grow out of feafon, as being too large. Others derive it from a Saxon word, fignifying *loaf-mafs*, becaufe on that day our forefathers made an offering of bread prepared with new wheat.

It is celebrated by the Romifh church in memory of St. Peter's imprifonment.

LAMPÆDIAS, a kind of bearded comet, refembling a burning lamp, being of feveral fhapes; for fometimes its flame or blaze runs tapering upwards like a fword, and fometimes it is double or treble pointed.

LANDEN (JOHN), an eminent mathematician, was born at Peakirk, near Peterborough in Northamptonfhire, in January 1719. He became very early a proficient in the mathematics, for we find him a very refpectable contributor to the Ladies Diary in 1744; and he was foon among the foremoft of thofe who then contributed to the fupport of that fmall but valuable publication, in which almoft every Englifh mathematician who has arrived at any degree of eminence for the beft part of this century, has contended for fame at one time or other of his life. Mr. Landen continued his contributions to it at times, under various fignatures, till within a few years of his death.

It has been frequently obferved, that the hiftories of literary men confift chiefly of the hiftory of their writings; and the obfervation was never more fully verified, than in the prefent article concerning Mr. Landen.

In the 48th volume of the Philofophical Tranfactions, for the year 1754, Mr. Landen gave "An Inveftigation of fome theorems which fuggeft feveral very remarkable properties of the Circle, and are at the fame time of confiderable ufe in refolving Fractions, the denominators of which are certain Multinomials, into more fimple ones, and by that means facilitate the computation of Fluents." This ingenious paper was delivered to the Society by that eminent mathematician Thomas Simpfon of Woolwich, a circumftance which will convey to thofe who are not themfelves judges of it, fome idea of its merit.

In the year 1755, he publifhed a volume of about 160 pages, intitled *Mathematical Lucubrations*. The title to this publication was made choice of, as a means of informing the world, that the ftudy of the mathematics was at that time rather the purfuit of his leifure hours, than his principal employment: and indeed it continued to be fo, during the greateft part of his life; for about the year 1762 he was appointed agent to Earl Fitzwilliam, an employment which he refigned only two years before his death. Thefe Lucubrations contain a variety of tracts relative to the rectification of curve lines, the fummation of feries, the finding of fluents, and many other points in the higher parts of the mathematics.

About the latter end of the year 1757, or the beginning of 1758, he publifhed propofals for printing by fubfcription, *The Refidual Analyfis*, a new Branch of the Algebraic art: and in 1758 he publifhed a fmall tract, entitled *A Difcourfe on the Refidual Analyfis*; in which he refolved a variety of problems, to which the method of fluxions had ufually been applied, by a mode of reafoning entirely new: he alfo compared thefe folutions with others derived from the fluxionary method; and fhewed that the folutions by his new method were commonly more natural and elegant than the fluxionary ones.

In the 51ft volume of the Philofophical Tranfactions, for the year 1760, he gave *A New Method of computing the Sums of a great number of Infinite Series*. This paper was alfo prefented to the Society by his ingenious friend the late Mr. Thomas Simpfon.

In 1764, he publifhed the firft book of *The Refidual Analyfis*. In this treatife, befides explaining the principles which his new analyfis was founded on, he applied it, in a variety of problems, to drawing tangents, and finding the properties of curve lines; to defcribing their involutes and evolutes, finding the radius of curvature, their greateft and leaft ordinates, and points of contrary flexure; to the determination of their cufps, and the drawing of afymptotes: and he propofed, in a fecond book, to extend the application of this new analyfis to a great variety of mechanical and phyfical fubjects. The papers which were to have formed this book lay long by him; but he never found leifure to put them in order for the prefs.

In the year 1766, Mr. Landen was elected a Fellow of the Royal Society. And in the 58th volume of the Philofophical Tranfactions, for the year 1768, he gave *A fpecimen of a New Method of comparing Curvilinear Areas*; by means of which many areas are compared, that did not appear to be comparable by any other method: a circumftance of no fmall importance in that part of natural philofophy which relates to the doctrine of motion.

In the 60th volume of the fame work, for the year 1770, he gave *Some New Theorems* for computing the Whole Areas of Curve Lines, where the Ordinates are expreffed

expreffed by Fractions of a certain form, in a more concife and elegant manner than had been done by Cotes, De Moivre, and others who had confidered the fubject before him.

In the 61ft volume, for 1771, he has inveftigated feveral new and ufeful theorems for computing certain fluents, which are affignable by arcs of the conic fections. This fubject had been confidered before, both by Maclaurin and d'Alembert; but fome of the theorems that were given by thefe celebrated mathematicians, being in part expreffed by the difference between an hyperbolic arc and its tangent, and that difference being not directly attainable when the arc and its tangent both become infinite, as they will do when the whole fluent is wanted, although fuch fluent be finite; thefe theorems therefore fail in thefe cafes, and the computation becomes impracticable without farther help. This defect Mr. Landen has removed, by affigning the *limit* of the difference between the hyperbolic arc and its tangent, while the point of contact is fuppofed to be removed to an infinite diftance from the vertex of the curve. And he concludes the paper with a curious and remarkable property relating to pendulous bodies, which is deducible from thofe theorems. In the fame year he publifhed *Animadverfions on Dr. Stewart's Computation of the Sun's Diftance from the Earth.*

In the 65th volume of the Philofophical Tranfactions, for 1775, he gave the inveftigation of a General Theorem, which he had promifed in 1771, for finding the Length of any Curve of a Conic Hyperbola by means of two Elliptic Arcs: and he obferves, that by the theorems there inveftigated, both the elaftic curve and the curve of equable recefs from a given point, may be conftructed in thofe cafes where Maclaurin's elegant method fails.

In the 67th volume, for 1777, he gave "A New Theory of the Motion of bodies revolving about an axis in free fpace, when that motion is difturbed by fome extraneous force, either percuffive or accelerative." At that time he did not know that the fubject had been treated by any perfon before him, and he confidered only the motion of a fphere, fpheroid, and cylinder. After the publication of this paper however he was informed, that the doctrine of rotatory motion had been confidered by d'Alembert; and upon procuring that author's *Opufcules Mathematiques*, he there learned that d'Alembert was not the only one who had confidered the matter before him; for d'Alembert there fpeaks of fome mathematician, though he does not mention his name, who, after reading what had been written on the fubject, doubted whether there be any folid whatever, befide the fphere, in which any line, paffing through the centre of gravity, will be a permanent axis of rotation. In confequence of this, Mr. Landen took up the fubject again; and though he did not then give a folution to the general problem, viz, "to determine the motions of a body of any form whatever, revolving without reftraint about any axis paffing through its centre of gravity," he fully removed every doubt of the kind which had been ftarted by the perfon alluded to by d'Alembert, and pointed out feveral bodies which, under certain dimenfions, have that remarkable property. This paper is given, among many others equally curious, in a volume of *Memoirs*, which he publifhed in the year 1780. That volume is alfo enriched with a very extenfive appendix, containing *Theorems for the Calculation of Fluents*; which are more complete and extenfive than thofe that are found in any author before him.

In 1781, 1782, and 1783, he publifhed three fmall Tracts on the Summation of Converging Series; in which he explained and fhewed the extent of fome theorems which had been given for that purpofe by De Moivre, Stirling, and his old friend Thomas Simpfon, in anfwer to fome things which he thought had been written to the difparagement of thofe excellent mathematicians. It was the opinion of fome, that Mr. Landen did not fhew lefs mathematical fkill in explaining and illuftrating thefe theorems, than he has done in his writings on original fubjects; and that the authors of them were as little aware of the extent of their own theorems, as the reft of the world were before Mr. Landen's ingenuity made it obvious to all.

About the beginning of the year 1782, Mr. Landen had made fuch improvements in his theory of Rotatory Motion, as enabled him, he thought, to give a folution of the general problem mentioned above; but finding the refult of it to differ very materially from the refult of the folution which had been given of it by d'Alembert, and not being able to fee clearly where that gentleman in his opinion had erred, he did not venture to make his own folution public. In the courfe of that year, having procured the Memoirs of the Berlin Academy for 1757, which contain M. Euler's folution of the problem, he found that this gentleman's folution gave the fame refult as had been deduced by d'Alembert; but the perfpicuity of Euler's manner of writing enabled him to difcover where he had differed from his own, which the obfcurity of the other did not do. The agreement, however, of two writers of fuch eftablifhed reputation as Euler and d'Alembert made him long dubious of the truth of his own folution, and induced him to revife the procefs again and again with the utmoft circumfpection; and being every time more convinced that his own folution was right, and theirs wrong, he at length gave it to the public, in the 75th volume of the Philofophical Tranfactions, for 1785.

The extreme difficulty of the fubject, joined to the concife manner in which Mr. Landen had been obliged to give his folution, to confine it within proper limits for the Tranfactions, rendered it too difficult, or at leaft too laborious a tafk for moft mathematicians to read it; and this circumftance, joined to the eftablifhed reputation of Euler and d'Alembert, induced many to think that their folution was right, and Mr. Landen's wrong; and there did not want attempts to prove it; particularly a long and ingenious paper by the learned Mr. Wildbore, a gentleman of very diftinguifhed talents and experience in fuch calculations; this paper is given in the 80th volume of the Philofophical Tranfactions, for the year 1790, in which he agrees with the folutions of Euler and d'Alembert, and againft that of Mr. Landen. This determined the latter to revife and extend his folution, and give it at greater length, to render it more generally underftood. About this time alfo he met by chance with the late Frifi's *Cofmographiæ Phyficæ et Mathematicæ*; in the fecond part of which

which there is a ſolution of this problem, agreeing in the reſult with thoſe of Euler and d'Alembert. Here Mr. Landen learned that Euler had reviſed the ſolution which he had given formerly in the Berlin Memoirs, and given it another form, and at greater length, in a volume publiſhed at Roſtoch and Gryphiſwald in 1765, intitled, *Theoria Motûs Corporum Solidorum ſeu Rigidorum*. Having therefore procured this book, Mr. Landen found the ſame principles employed in it, and of courſe the ſame concluſion reſulting from them, as in M. Euler's former ſolution of the problem. But notwithſtanding that there were thus a coincidence of at leaſt four moſt reſpectable mathematicians againſt him, Mr. Landen was ſtill perſuaded of the truth of his own ſolution, and prepared to defend it. And as he was convinced of the neceſſity of explaining his ideas on the ſubject more fully, ſo he now found it neceſſary to loſe no time in ſetting about it. He had for ſeveral years been ſeverely afflicted with the ſtone in the bladder, and towards the latter part of his life to ſuch a degree as to be confined to his bed for more than a month at a time: yet even this dreadful diſorder did not extinguiſh his ardour for mathematical ſtudies; for the ſecond volume of his *Memoirs*, lately publiſhed, was written and reviſed during the intervals of his diſorder. This volume, beſides a ſolution of the general problem concerning rotatory motion, contains the reſolution of the problem relating to the motion of a Top; with an inveſtigation of the motion of the Equinoxes, in which Mr. Landen has firſt of any one pointed out the cauſe of Sir Iſaac Newton's miſtake in his ſolution of this celebrated problem; and ſome other papers of conſiderable importance. He juſt lived to ſee this work finiſhed, and received a copy of it the day before his death, which happened on the 15th of January 1790, at Milton, near Peterborough, in the 71ſt year of his age.

LARBOARD, the left hand ſide of a ſhip, when a perſon ſtands with his face towards the head.

LARMIER, in Architecture, a flat ſquare member of the cornice below the cimaſium, and jets out fartheſt; being ſo called from its uſe, which is to diſperſe the water, and cauſe it to fall at a diſtance from the wall, drop by drop, or, as it were, by tears; *larme* in French ſignifying a tear.

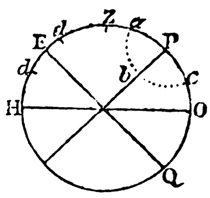
LATERAL EQUATION, in Algebra, is the ſame with ſimple equation. It has but one root, and may be conſtructed by right lines only.

LATION, is uſed by ſome, for the tranſlation or motion of a body from one place to another.

LATITUDE, in Geography, or Navigation, the diſtance of a place from the equator; or an arch of the meridian, intercepted between its zenith and the equator. Hence the Latitude is either north or ſouth, according as the place is on the north or ſouth ſide of the equator: thus London is ſaid to be in 51° 31′ of north latitude.

Circles parallel to the equator are called *parallels of latitude*, becauſe they ſhew the latitudes of places by their interſections with the meridian.

The Latitude of a place is equal to the elevation of the pole above the horizon of the place: and hence theſe two terms are uſed indifferently for each other.



This will be evident from the figure, where the circle ZHQP is the meridian, Z the zenith of the place, HO the horizon, EQ the equator, and P the pole; then is ZE the latitude, and PO the elevation of the pole above the horizon. And becauſe PE is = ZO, being each a quadrant, if the common part PZ be taken from both, there will remain the latitude ZE = PO the elevation of the pole.—Hence we have a method of meaſuring the circumference of the earth, or of determining the quantity of a degree on its ſurface; for by meaſuring directly northward or ſouthward, till the pole be one degree higher or lower, we ſhall have the number of miles in a degree of a great circle on the ſurface of the earth; and conſequently multiplying that by 360, will give the number of miles round the whole circumference of the earth.

The knowledge of the Latitude of the place, is of the utmoſt conſequence, in geography, navigation, and aſtronomy; it may be proper therefore to lay down ſome of the beſt ways of determining it, both by ſea and land.

1ſt. One method is, to find the Latitude of the pole, to which it is equal, by means of the pole ſtar, or any other circumpolar ſtar, thus: Either draw a true meridian line, or find the times when the ſtar is on the meridian, both above and below the pole; then at theſe times, with a quadrant, or other fit inſtrument, take the altitudes of the ſtar; or take the ſame when the ſtar comes upon your meridian line; which will be the greateſt and leaſt altitude of the ſtar: then ſhall half the ſum of the two be the elevation of the pole, or the latitude ſought.—For, if abc be the path of the ſtar about the pole P, Z the zenith, and HO the horizon: then is aO the altitude of the ſtar upon the meridian when above the pole, and cO the ſame when below the pole; hence, becauſe $aP = cP$, therefore $aO + cO = 2OP$, hence the height of the pole OP, or latitude of Z, is equal to half the ſum of aO and cO.

2d. A ſecond method is by means of the declination of the ſun, or a ſtar, and one meridian altitude of the ſame, thus: Having, with a quadrant, or other inſtrument, obſerved the zenith diſtance Zd of the luminary; or elſe its altitude Hd, and taken its complement Zd; then to this zenith diſtance, add the declination dE when the luminary and place are on the ſame ſide of the equator, or ſubtract it when on different ſides, and the ſum or difference will be the latitude EZ ſought. But note, that all altitudes obſerved, muſt be corrected for refraction and the dip of the horizon, and for the ſemidiameter of the ſun, when that is the luminary obſerved.

Many other methods of obſerving and computing the Latitude may be ſeen in Robertſon's Navigation; ſee book 5 and book 9. See alſo the Nautical Almanac for 1771.

Mr. Richard Graham contrived an ingenious inſtrument for taking the latitude of a place at any time of the day. See Philoſ. Tranſ. N°. 435, or Abr. vol. 8. pa. 371.

LATITUDE, in Aſtronomy, as of a ſtar or planet, is its diſtance from the ecliptic, being an arch of a circle of latitude, reckoned from the ecliptic towards its poles, either north or ſouth. Hence, the aſtronomical latitude is quite different from the geographical, the former meaſuring from the ecliptic, and the latter from the equator, ſo that this latter anſwers to the declination in aſtronomy, which meaſures from the equinoctial.

The ſun has no latitude, being always in the ecliptic; but all the ſtars have their ſeveral latitudes, and the planets are continually changing their latitudes, ſometimes north, and ſometimes ſouth, croſſing the ecliptic from the one ſide to the other; the points in which they croſs the ecliptic being called the *nodes* of the planet, and in theſe points it is that they can paſs over the face of the ſun, or behind his body, viz, when they come both to this point of the ecliptic at the ſame time.

Circle of LATITUDE, is a great circle paſſing through the poles of the ecliptic, and conſequently perpendicular to it, like as the meridians are perpendicular to the equator, and paſs through its poles.

LATITUDE, *of the Moon, North aſcending*, is when ſhe proceeds from the aſcending node towards her northern limit, or greateſt elongation.

LATITUDE, *North deſcending*, is when the moon returns from her northern limit towards the deſcending node.

LATITUDE, *South deſcending*, is when ſhe proceeds from the deſcending node towards her ſouthern limit.

LATITUDE, *South aſcending*, is when ſhe returns from her ſouthern limit towards her aſcending node.

And the ſame is to be underſtood of the other planets.

Heliocentric LATITUDE, of a planet, is its latitude, or diſtance from the ecliptic, ſuch as it would appear from the ſun.—This, when the planet comes to the ſame point of its orbit, is always the ſame, or unchangeable.

Geocentric LATITUDE, of a planet, is its latitude as ſeen from the earth.—This, though the planet be in the ſame point of its orbit, is not always the ſame, but alters according to the poſition of the earth, in reſpect to the planet.

The latitude of a ſtar is altered only by the aberration of light, and the ſecular variation of latitude.

Difference of LATITUDE, is an arc of the meridian, or the neareſt diſtance between the parallels of latitude of two places. When the two latitudes are of the ſame name, either both north or both ſouth, ſubtract the leſs latitude from the greater, to give the difference of latitude; but when they are of different names, add them together for the difference of latitude.

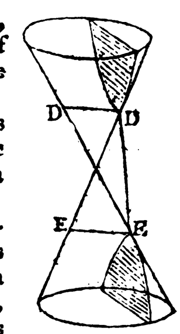
Middle LATITUDE, is the middle point between two latitudes or places; and is found by taking half the ſum of the two.

Parallax of LATITUDE. See PARALLAX.

Refraction of LATITUDE. See REFRACTION.

LATUS RECTUM, in Conic Sections, the ſame with parameter; which ſee.

LATUS *Tranſverſum*, of the hyperbola, is the right line between the vertices of the two oppoſite ſections; or that part of their common axis lying between the two oppoſite cones; as the line DE. It is the ſame as the tranſverſe axis of the hyperbola, or oppoſite hyperbolas.



LATUS *Primarium*, a right line, DD, or EE, drawn through the vertex of the ſection of a cone, within the ſame, and parallel to the baſe.

LEAGUE, an extent of three miles in length. A nautical league, or three nautical miles, is the 20th part of a degree of a great circle.

LEAP-YEAR, the ſame as BISSEXTILE; which ſee. It is ſo called from its leaping a day more that year than in a common year; conſiſting of 366 days, and a common year only of 365. This happens every 4th year, except only ſuch complete centuries as are not exactly diviſible by 4; ſuch as the 17th, 18th, 19th, 21ſt &c. centuries, becauſe 17, 18, 19, 21, &c, cannot be divided by 4 without a remainder.

To find Leap Year, &c. Divide the number of the year by 4; then if 0 remain, it is leap year; but if 1, 2, or 3 remain, it is ſo many after leap-year.

Or the rule is ſometimes thus expreſſed, in theſe two memorial verſes:

Divide by 4; what's left ſhall be,
For leap-year 0; for paſt, 1, 2, or 3.

Thus if it be required to know what year 1790 is:

then 4) 1790 (447
2 remains:

ſo that 2 remaining, ſhews that 1790 is the 2d year after leap-year. And to find what year 1796 is:

then 4) 1796 (449

here 0 remaining, ſhews that 1796 is a leap-year.

LEAVER. See LEVER.

LEE, a term in Navigation, ſignifying that ſide, or quarter, towards which the wind blows.

LEE-WAY, of a Ship, is the angle made by the point of the compaſs ſteered upon, and the real line of the ſhip's way, occaſioned by contrary winds and a rough ſea.

All ſhips are apt to make ſome lee-way; ſo that ſomething muſt be allowed for it, in caſting up the log-board. But the lee-way made by different ſhips, under ſimilar circumſtances of wind and ſails, is different; and even the ſame ſhip, with different lading, and having more or leſs ſail ſet, will have more or leſs lee-way. The uſual allowances for it are theſe, as they were given by Mr. John Buckler to the late ingenious Mr. William Jones, who firſt publiſhed them in 1702 in his *Compendium of Practical Navigation*. 1ſt, When a ſhip is cloſe-hauled, has all her ſails ſet, the ſea ſmooth, and a moderate gale of wind, it is then ſuppoſed ſhe makes little or no lee-way. 2d, Allow one point, when it blows ſo freſh that the ſmall ſails are taken in. 3d, Allow two points, when the topſail muſt be cloſe reefed. 4th, Allow two points and a half, when one topſail muſt be handed. 5th, Allow three points and a half, when both topſails muſt be taken in. 6th, Allow four points, when the fore-courſe is handed. 7th, Allow five points, when trying under the mainſail only. 8th, Allow ſix points, when both main and fore-courſes are taken in. 9th,