

On Infinites in Geometry, and Sir Isaac Newton's Chronology

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The labyrinth and abyss of infinity is also a new course Sir Isaac Newton has gone through, and we are obliged to him for the clue, by whose assistance we are enabled to trace its various windings.

Descartes got the start of him also in this astonishing invention. He advanced with mighty steps in his geometry, and was arrived at the very borders of infinity, but went not farther. Dr. Wallis, about the middle of the last century, was the first who reduced a fraction by a perpetual division to an infinite series.

The Lord Brouncker employed this series to square the hyperbola. Mercator published a demonstration of this quadrature; much about which time Sir Isaac Newton, being then twenty-three years of age, had invented a general method, to perform on all geometrical curves what had just before been tried on the hyperbola.

It is to this method of subjecting everywhere infinity to algebraical calculations, that the name is given of differential calculations or of fluxions and integral calculation. It is the art of numbering and measuring exactly a thing whose existence cannot be conceived.

And, indeed, would you not imagine that a man laughed at you who should declare that there are lines infinitely great which form an angle infinitely little?

That a right line, which is a right line so long as it is finite, by changing infinitely little its direction, becomes an infinite curve; and that a curve may become infinitely less than another curve?

That there are infinite squares, infinite cubes, and infinites of infinites, all greater than one another, and the last but one of which is nothing in comparison of the last?

All these things, which at first appear to be the utmost excess of frenzy, are in reality an effort of the subtlety and extent of the human mind, and the art of finding truths which till then had been unknown.

This so bold edifice is even founded on simple ideas. The business is to measure the diagonal of a square, to give the area of a curve, to find the square root of a number, which has none in common arithmetic. After all, the imagination ought not to be startled any more at so many orders of infinites than at the so well-known proposition, viz., that curve lines may always be made to pass between a circle and a tangent, or

at that other, namely, that matter is divisible in infinitum. These two truths have been demonstrated many years, and are no less incomprehensible than the things we have been speaking of.

For many years the invention of this famous calculation was denied to Sir Isaac Newton. In Germany Mr. Leibnitz was considered as the inventor of the differences or moments, called fluxions, and Mr. Bernoulli claimed the integral calculus. However, Sir Isaac is now thought to have first made the discovery, and the other two have the glory of having once made the world doubt whether it was to be ascribed to him or them. Thus some contested with Dr. Harvey the invention of the circulation of the blood, as others disputed with Mr. Perrault that of the circulation of the sap.

Hartsocher and Leuwenhoek disputed with each other the honour of having first seen the vermiculi of which mankind are formed. This Hartsocher also contested with Huygens the invention of a new method of calculating the distance of a fixed star. It is not yet known to what philosopher we owe the invention of the cycloid.

Be this as it will, it is by the help of this geometry of infinites that Sir Isaac Newton attained to the most sublime discoveries. I am now to speak of another work, which, though more adapted to the capacity of the human mind, does nevertheless display some marks of that creative genius with which Sir Isaac Newton was informed in all his researches. The work I mean is a chronology of a new kind, for what province soever he undertook he was sure to change the ideas and opinions received by the rest of men.

Accustomed to unravel and disentangle chaos, he was resolved to convey at least some light into that of the fables of antiquity which are blended and confounded with history, and fix an uncertain chronology. It is true that there is no family, city, or nation, but endeavours to remove its original as far backward as possible. Besides, the first historians were the most negligent in setting down the eras: books were infinitely less common than they are at this time, and, consequently, authors being not so obnoxious to censure, they therefore imposed upon the world with greater impunity; and, as it is evident that these have related a great number of fictitious particulars, it is probable enough that they also gave us several false eras.

It appeared in general to Sir Isaac that the world was five hundred years younger than chronologers declare it to be. He grounds his opinion on the ordinary course of Nature, and on the observations which astronomers have made.

By the course of Nature we here understand the time that every generation of men lives upon the earth. The Egyptians first employed this vague and uncertain method of calculating when they began to write the beginning of their history. These computed three hundred and forty-one generations from Menes to Sethon; and, having no fixed

era, they supposed three generations to consist of a hundred years. In this manner they computed eleven thousand three hundred and forty years from Menes' reign to that of Sethon.

The Greeks before they counted by Olympiads followed the method of the Egyptians, and even gave a little more extent to generations, making each to consist of forty years.

Now, here, both the Egyptians and the Greeks made an erroneous computation. It is true, indeed, that, according to the usual course of Nature, three generations last about a hundred and twenty years; but three reigns are far from taking up so many. It is very evident that mankind in general live longer than kings are found to reign, so that an author who should write a history in which there were no dates fixed, and should know that nine kings had reigned over a nation; such a historian would commit a great error should he allow three hundred years to these nine monarchs. Every generation takes about thirty-six years; every reign is, one with the other, about twenty. Thirty kings of England have swayed the sceptre from William the Conqueror to George I., the years of whose reigns added together amount to six hundred and forty-eight years; which, being divided equally among the thirty kings, give to every one a reign of twenty-one years and a half very near. Sixty-three kings of France have sat upon the throne; these have, one with another, reigned about twenty years each. This is the usual course of Nature. The ancients, therefore, were mistaken when they supposed the durations in general of reigns to equal that of generations. They, therefore, allowed too great a number of years, and consequently some years must be subtracted from their computation.

Astronomical observations seem to have lent a still greater assistance to our philosopher. He appears to us stronger when he fights upon his own ground.

You know that the earth, besides its annual motion which carries it round the sun from west to east in the space of a year, has also a singular revolution which was quite unknown till within these late years. Its poles have a very slow retrograde motion from east to west, whence it happens that their position every day does not correspond exactly with the same point of the heavens. This difference which is so insensible in a year, becomes pretty considerable in time; and in threescore and twelve years the difference is found to be of one degree, that is to say, the three hundred and sixtieth part of the circumference of the whole heaven. Thus after seventy-two years the colure of the vernal equinox which passed through a fixed star, corresponds with another fixed star. Hence it is that the sun, instead of being in that part of the heavens in which the Ram was situated in the time of Hipparchus, is found to correspond with that part of the heavens in which the Bull was situated; and the Twins are placed where the Bull then stood. All the signs have changed their situation, and yet we still retain the same



manner of speaking as the ancients did. In this age we say that the sun is in the Ram in the spring, from the principle of condescension that we say that the sun turns round.

Hipparchus was the first among the Greeks who observed some change in the constellations with regard to the equinoxes, or rather who learnt it from the Egyptians. Philosophers ascribed this motion to the stars; for in those ages people were far from imagining such a revolution in the earth, which was supposed to be immovable in every respect. They therefore created a heaven in which they fixed the several stars, and gave this heaven a particular motion by which it was carried towards the east, whilst that all the stars seemed to perform their diurnal revolution from east to west. To this error they added a second of much greater consequence, by imagining that the pretended heaven of the fixed stars advanced one degree eastward every hundred years. In this manner they were no less mistaken in their astronomical calculation than in their system of natural philosophy. As for instance, an astronomer in that age would have said that the vernal equinox was in the time of such and such an observation, in such a sign, and in such a star. It has advanced two degrees of each since the time that observation was made to the present. Now two degrees are equivalent to two hundred years; consequently the astronomer who made that observation lived just so many years before me. It is certain that an astronomer who had argued in this manner would have mistook just fifty-four years; hence it is that the ancients, who were doubly deceived, made their great year of the world, that is, the revolution of the whole heavens, to consist of thirty-six thousand years. But the moderns are sensible that this imaginary revolution of the heaven of the stars is nothing else than the revolution of the poles of the earth, which is performed in twenty-five thousand nine hundred years. It may be proper to observe transiently in this place, that Sir Isaac, by determining the figure of the earth, has very happily explained the cause of this revolution.

All this being laid down, the only thing remaining to settle chronology is to see through what star the colure of the equinoxes passes, and where it intersects at this time the ecliptic in the spring; and to discover whether some ancient writer does not tell us in what point the ecliptic was intersected in his time, by the same colure of the equinoxes.

Clemens Alexandrinus informs us, that Chiron, who went with the Argonauts, observed the constellations at the time of that famous expedition, and fixed the vernal equinox to the middle of the Ram; the autumnal equinox to the middle of Libra; our summer solstice to the middle of Cancer, and our winter solstice to the middle of Capricorn.

A long time after the expedition of the Argonauts, and a year before the Peloponnesian war, Methon observed that the point of the summer solstice passed through the eighth degree of Cancer.

Now every sign of the zodiac contains thirty degrees. In Chiron's time, the solstice was arrived at the middle of the sign, that is to say to the fifteenth degree. A year before the Peloponnesian war it was at the eighth, and therefore it had retarded seven degrees. A degree is equivalent to seventy-two years; consequently, from the beginning of the Peloponnesian war to the expedition of the Argonauts, there is no more than an interval of seven times seventy-two years, which make five hundred and four years, and not seven hundred years, as the Greeks computed. Thus in comparing the position of the heavens at this time with their position in that age, we find that the expedition of the Argonauts ought to be placed about nine hundred years before Christ, and not about fourteen hundred; and consequently that the world is not so old by five hundred years as it was generally supposed to be. By this calculation all the eras are drawn nearer, and the several events are found to have happened later than is computed. I don't know whether this ingenious system will be favourably received; and whether these notions will prevail so far with the learned, as to prompt them to reform the chronology of the world. Perhaps these gentlemen would think it too great a condescension to allow one and the same man the glory of having improved natural philosophy, geometry, and history. This would be a kind of universal monarchy, with which the principle of self-love that is in man will scarce suffer him to indulge his fellow-creature; and, indeed, at the same time that some very great philosophers attacked Sir Isaac Newton's attractive principle, others fell upon his chronological system. Time, that should discover to which of these the victory is due, may perhaps only leave the dispute still more undetermined.