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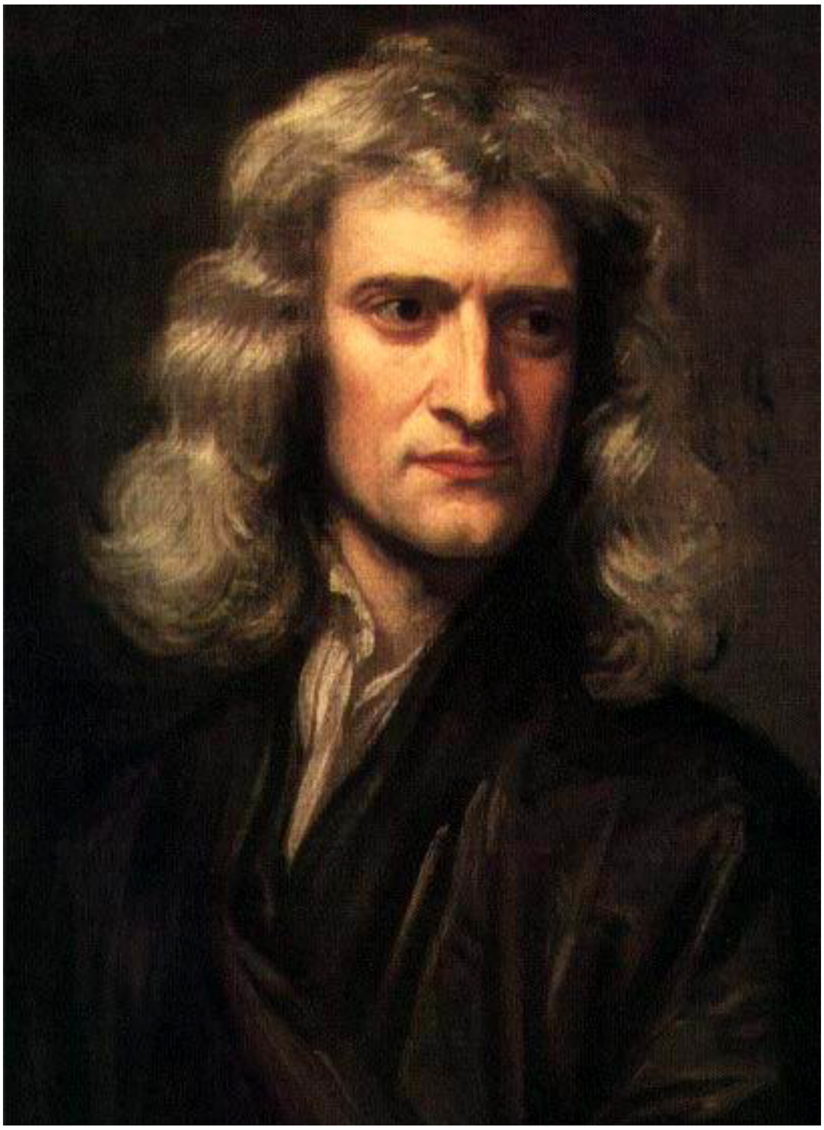
daily blog on science, tech & art in history

Standing on the Shoulders of Giants – Sir Isaac Newton



Sir Isaac Newton (1643-1727), Portrait by Sir Godfrey Kneller (1689)

On January 4, 1643 [N.S.] (25 December 1642 [O.S.]), **Sir Isaac Newton**, famous physicist, mathematician, astronomer, natural philosopher, alchemist and theologian, was born. With his *Principia* Newton laid the foundation of modern classical mechanics. Besides he constructed the very first reflecting telescope and independent of Gottfried Wilhelm Leibniz developed differential and integral calculus [10].

"We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances."
— Isaac Newton, Philosophiae Naturalis Principia Mathematica (1687), "Rules of Reasoning in Philosophy" : Rule I

Isaac Newton – An Education

On January 4, 1643, (December 25, 1642 according to the old Julian calendar) Isaac Newton was born in the hamlet of Woolsthorpe, in Lincolnshire, England, the only son of a prosperous local farmer, also named Isaac Newton. Young Isaac never knew his father, who died three months before he was born. A premature baby born tiny and weak, Isaac was not expected to survive. When he was three, his mother remarried a minister, Barnabas Smith, and went to live with him, leaving young Isaac with his maternal grandmother. At age twelve, Isaac Newton was reunited with his mother after her second husband died. Although he had been enrolled at the King's School, Grantham, England, his mother pulled him out of school, for her plan was to make him a farmer and have him tend the farm. But, Isaac failed miserably for he found farming rather monotonous. Soon he was returned to King's School to finish his basic education.

Sizar in Cambridge

The turning point in Newton's life came in June 1661 when he left for Cambridge University, the outstanding center of learning in these days. He was older than most of his fellow students but, despite the fact that his mother was financially well off, he entered as a sizar. A sizar at Cambridge was a student who received an allowance toward college expenses in exchange for acting as a servant to other students. There is certainly some ambiguity in his position as a sizar, for he seems to have associated with "better class" students rather than other sizars [13].

Certain Philosophical Questions

In 1664 Isaac Barrow, Lucasian Professor of Mathematics at Cambridge, examined Newton's understanding of Euclid and found it sorely lacking. This was partly because Newton was rather occupied with his private study of the works of René Descartes [8], Pierre Gassendi [9], Thomas Hobbes [3], and other major figures of the scientific revolution. The mechanics of the Copernican astronomy of Galileo attracted him and he also studied Kepler's *Optics*. He recorded his thoughts in a book which he entitled *Quaestiones Quaedam Philosophicae* (*Certain Philosophical Questions*).[13] In 1665 Newton took his bachelor's degree. Since the university was closed for the next two years because of plague, Newton returned to Woolsthorpe in midyear, where in the following 18 months, he made a series of original contributions to science. In mathematics Newton conceived his '*method of fluxions*' (infinitesimal calculus), laid the foundations for his theory of light and color, and achieved significant insight into the problem of planetary motion, insights that eventually led to the publication of his *Principia* in 1687.

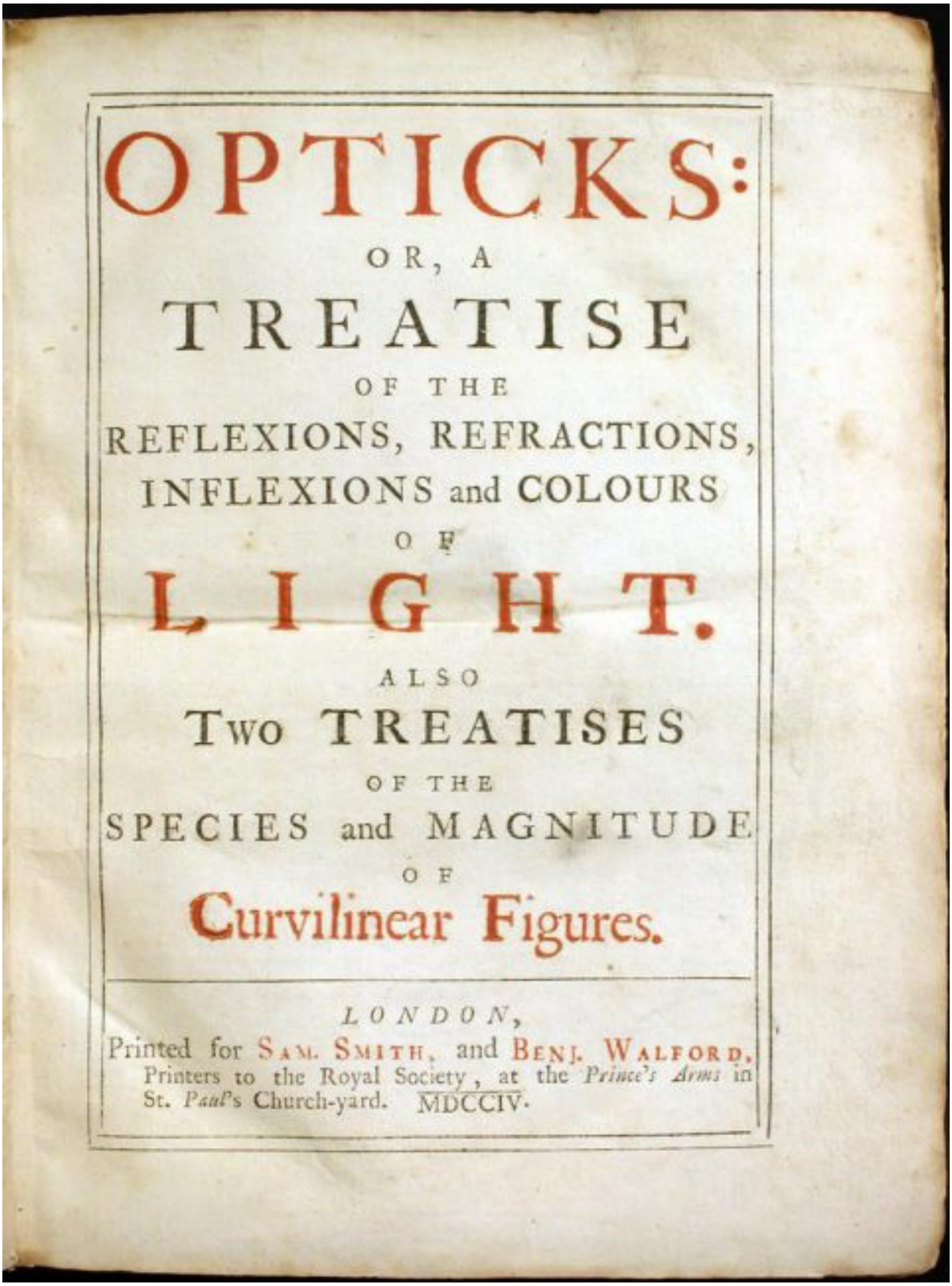
Differential Calculus

The ‘method of fluxions’, as he termed it, was based on his crucial insight that the integration of a function is merely the inverse procedure to differentiating it. Taking differentiation as the basic operation, Newton produced simple analytical methods that unified many separate techniques previously developed to solve apparently unrelated problems such as finding areas, tangents, the lengths of curves and the maxima and minima of functions.[13] In his works, Newton rephrased his ideas to suit the mathematical idiom of the time, replacing calculations with infinitesimals by equivalent geometrical arguments which were considered beyond reproach. He used the methods of calculus to solve the problem of planetary motion, the shape of the surface of a rotating fluid, the oblateness of the earth, the motion of a weight sliding on a cycloid, and many other problems discussed in his *Principia Mathematica* (1687). In other work, he developed series expansions for functions, including fractional and irrational powers, and it was clear that he understood the principles of the Taylor series. He did not publish all these discoveries, and at this time infinitesimal methods were still considered disreputable. These ideas were arranged into a true calculus of infinitesimals by Gottfried Wilhelm Leibniz, who was originally accused of plagiarism by Newton.

The Nature of Color

In 1667, Newton returned to Cambridge, where in the next year he became a senior fellow upon taking his master of arts degree, and in 1669, he succeeded Isaac Barrow as Lucasian Professor of Mathematics. Incredible, if you take into account that Newton was barely 27 years of age. He had reached the conclusion during the two plague years that white light is not a simple entity. Every scientist since Aristotle had believed that white light was a basic single entity, but the chromatic aberration in a telescope lens convinced Newton otherwise. When he passed a thin beam of sunlight through a glass prism Newton noted the spectrum of colors that was formed. He argued that white light is really a mixture of many different types of rays which are refracted at slightly different angles, and that each different type of ray produces a different spectral color. Newton was led by this reasoning to the erroneous conclusion that telescopes using refracting lenses would always suffer chromatic aberration. He therefore proposed and constructed a reflecting telescope. [13] At Cambridge, Newton was able to organize the results of his optical researches and in 1672, shortly after his election to the Royal Society after donating his reflecting telescope, he communicated his first public paper, a brilliant but no less controversial study on the nature of color.

“Hypotheses non fingo”. (I frame no hypotheses.),
— Isaac Newton, Philosophiae Naturalis Principia Mathematica, Third edition



OPTICKS:

OR, A

TREATISE

OF THE

REFLEXIONS, REFRACTIONS, INFLEXIONS and COLOURS

OF

LIGHT.

ALSO

Two TREATISES

OF THE

SPECIES and MAGNITUDE

OF

Curvilinear Figures.

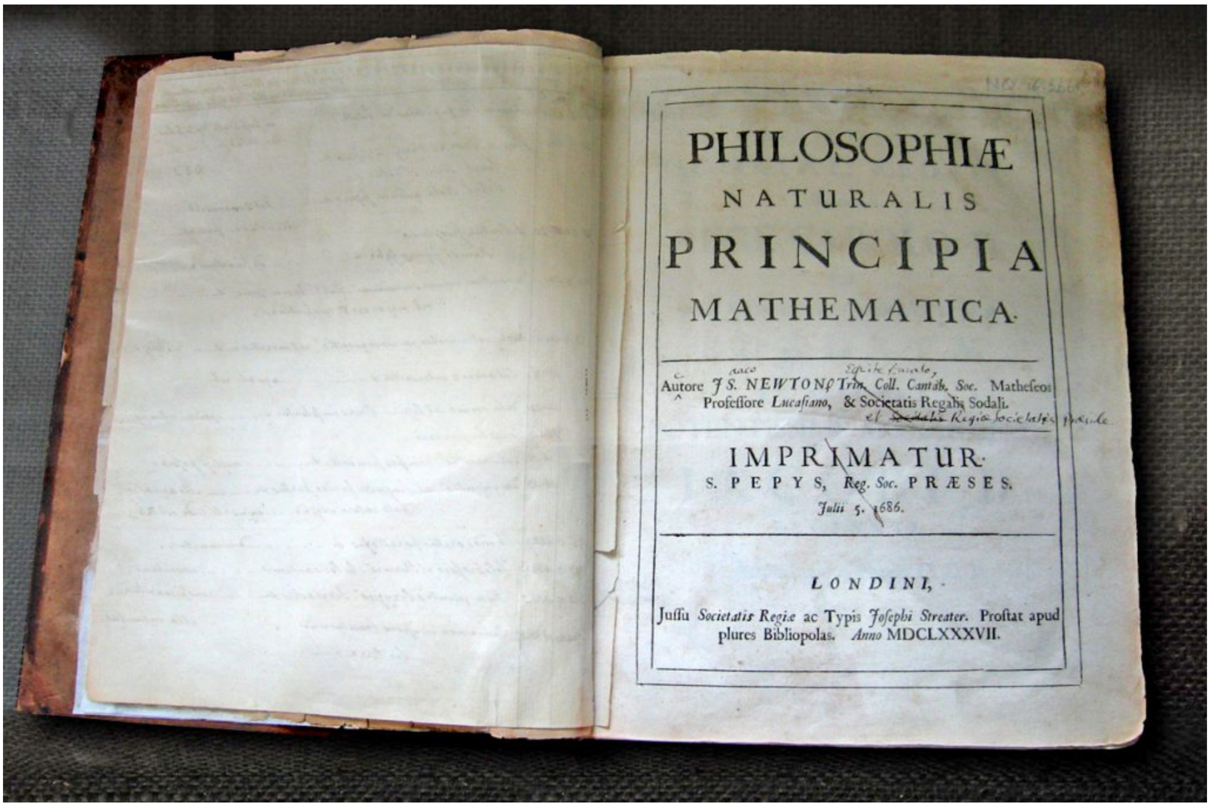
LONDON,

Printed for SAM. SMITH, and BENJ. WALFORD, Printers to the Royal Society, at the *Prince's Arms* in St. *Paul*'s Church-yard. MDCCIV.

Cover page of Isaac Newton's "Opticks or a treatise of the reflections, refractions, inflections and colours of light", 1730

Principia Mathematica

Due to a dispute with his fellow scientist Robert Hooke,[17] who claimed that Newton had stolen some of his optical results, Newton turned in on himself and away from the Royal Society which he associated with Hooke as one of its leaders. He even delayed the publication of a full account of his optical researches until after the death of Hooke in 1703. Newton's *Opticks* appeared in 1704. In 1687, with the support of his friend the astronomer Edmond Halley [6], Newton published his single greatest work, the '*Philosophiae Naturalis Principia Mathematica*', in which he showed how a universal force, gravity, applied to all objects in all parts of the universe. The *Principia* is recognized as the greatest scientific book ever written. Newton analyzed the motion of bodies in resisting and non-resisting media under the action of centripetal forces. The results were applied to orbiting bodies, projectiles, pendulums, and free-fall near the Earth. He further demonstrated that the planets were attracted toward the Sun by a force varying as the inverse square of the distance and generalized that all heavenly bodies mutually attract one another.[13]



Sir Isaac Newton's own first edition copy of his *Philosophiae Naturalis Principia Mathematica* with his handwritten corrections for the twentieth edition.

Warden of the Mint

In 1689, Newton was elected member of parliament for Cambridge University and in 1696, by the support of his friend and ex-student, Charles Montagu, 1st Earl of Halifax, Newton was appointed warden of the Royal Mint, settling in London. He took his duties at the Mint very seriously and campaigned against corruption and inefficiency within the organisation. As a scholar, Newton held court in the fashionable London coffee houses, surrounded by his acolytes, for whom the term Newtonians was originally minted, handing out unpublished manuscripts to the favored few for their perusal and edification [15]. Newton was made President of the Royal Society in 1703 and an associate of the French Académie des Sciences. In his position at the Royal Society, Newton made an enemy of John Flamsteed, the Astronomer Royal, by prematurely publishing Flamsteed's *Historia Coelestis Britannica*, which Newton had used in his studies.[16]

In April 1705, Queen Anne knighted Newton during a royal visit to Trinity College, Cambridge. Newton was referred to being a rather difficult man, prone to depression and often involved in bitter arguments with other scientists, but by the early 1700s he was the dominant figure in British and European science. Isaac Newton died on 31 March 1727 [NS] (20 March 1726 [OS]) at age 84 and was buried in Westminster Abbey.

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