Isaac Newton (1642/43 – 1727)

Outside the British Library in London there is a bronze statue of Isaac Newton, by Sir Eduardo Paulozzi, based on an engraving by the English mystical poet and artist William Blake. It shows Newton naked and muscular, sitting on a block and bent double, eyes focussed on a divider with which he has marked out something – presumably the order of the universe, in a poet's understanding of the scientist's vocation. Blake lived in the century after Newton, at the same time as Pierre-Simon de Laplace, the French mathematician whose great work on celestial mechanics started where Newton's *Principia* ended. Laplace demonstrated, among other things, the long-term stability of the solar system. On being presented this work Napoleon is supposed to have asked Laplace what role God had to play in his scheme of things, to which Laplace replied that God was a hypothesis of which he had no need, since it explained everything but predicted nothing! The supposed ability of the Newtonian mechanics to predict the course of the world was a shock to the religion-infused Middle Ages in Europe, where God's supervisory role in everyday life was taken for granted. It is the disdain of a mystic for the man ultimately responsible for this worldview that Blake's engraving of Newton is thought to represent. I like to think, however, that what stirred Blake was an inkling that behind the cold front of Isaac Newton, this god of Godless science, there was a heart that sought out ultimate order with just as great a passion as his own.

Isaac Newton was born on Christmas Day 1642 (which, when the Gregorian calendar was adopted by England in 1752, became 4th January 1643), two months after his father died, to Hannah Ayscough of Woolsthorpe, Lincolnshire, England. When he was two, his mother remarried and left him to the care of her parents. Isaac was unhappy at this abandonment. He was briefly re-united with his mother in 1653, when her second husband died. Shortly thereafter he was sent to nearby Grantham to attend its Free Grammar School. His mother withdrew him from school when reports came in that he was "idle" and "inattentive", and sent him to manage the considerable properties left to her by Isaac's father (a well-to-do but illiterate man of farmer stock), a task at which he proved inept. He was sent back to the school in about 1659, at the instance of his uncle William Ayscough and the headmaster of the school, and there he was prepared for admission to the university.

In 1661 he went to Trinity College, Cambridge, to study law. He was enrolled as a sizar, i.e. a student who earns an allowance as a servant or helper to another, in this case Humphrey Babington, a distant relative who did not make much of an imposition on Isaac. At any rate, he had time enough to read extensively – not just the canonical Aristotle, but also Descartes, Hobbes, Boyle, Galileo, Kepler, and others. He also learned mathematics seriously – from Euclid and Descartes, and from Wallis, whose work on algebra inspired Isaac to try proving theorems his own way ("Thus Wallis doth it, but it may be done thus…"). By 1665, when Isaac graduated from Cambridge, his mind was ripe for the two-year hiatus from university life that followed when Cambridge had to be closed for the duration of the Great Plague of London (which spread to Cambridge). Isaac returned to Lincolnshire, and in the two following years cultivated in solitude, the many ideas that Cambridge had sown in his fertile mind. From this emerged the great works for which he later became famous – on calculus, gravity and mechanics, and optics.

Newton returned to Trinity in 1667, where he was elected Fellow in 1668, giving him the freedom to continue his researches. Though Newton was reluctant to publish, his extraordinary discoveries in mathematics and natural philosophy soon became known to the scientific community at Cambridge and beyond. This was primarily the result of the interest and encouragement of Isaac Barrow, the first Lucasian Professor of Mathematics, and his correspondence on Newton's work with the mathematician John Collins, who forwarded it to the President of the Royal Society.

In 1669 Barrow resigned from the Lucasian professorship, recommending Newton as successor. In 1670 Newton delivered his first lectures – on optics – as Lucasian Professor. The work that Newton did on optics at this time, both experimental and theoretical, led to the publication in 1704 of his famous work *Opticks* (the thirty-year delay in publication being partly the result of Newton's feuding with Robert Hooke, after whose death the book was published). Newton continued his work on mechanics and astronomy, corresponding with the well-known astronomer Edmond Halley, who had been able to show that Kepler's third law implied an inverse-square law of attraction. Halley discovered that Newton's researches went much deeper, and strongly encouraged him to publish his work. This led in 1687 to the publication of *Philosophiæ Naturalis Principia Mathematica*, the preface to the first edition of which begins with the words "Since the ancients … made great account of the science of mechanics in the

investigation of natural things; and the moderns, laying aside substantial forms and occult qualities, have endeavoured to subject the phænomena of nature to the laws of mathematics, I have in this treatise cultivated mathematics so far as it regards philosophy." In this – the cultivation of mathematics so far as it regards philosophy – Newton succeeded so completely that his methods became the archetype of the physicist's practice. The watertight logic of mathematically reasoned natural philosophy also had the effect of making God an unnecessary hypothesis.

Yet Newton was a deeply religious man. In the Middle Ages in England it was taken for granted that everyone would be affiliated to the Church. But Newton's interest in religion went far beyond affiliation to a church. In the *General Scholium*, an essay that was included in the 3rd edition of the *Principia*, he wrote "This most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being" and then went on, at some length, to deduce the qualities of an omnipresent God. He wrote extensively on religion, engaging himself not just in interpretations of Christian concepts like the Trinity but also in practices that today we would associate with cranks and charlatans, e.g. numerology based on numbers appearing in the Bible.

In fact there was a strain in Newton that was deeply sympathetic to the supernatural. In 1936 a trunk filled with Newton's notebooks was auctioned by Sotheby's and acquired by the economist John Maynard Keynes. These notebooks had been examined by the Royal Society after Newton's death, and deemed unfit for printing. Keynes was fascinated to discover that they contained, in great detail, accounts of Newton's secret researches on alchemy, carried on during the very years when he was becoming famous as a mathematical philosopher. Keynes was invited by the Royal Society to speak at Newton's tercentenary celebrations (which took place in 1946); though he died before the event, the text of his proposed lecture, entitled *Newton, the Man*, survives and contains the famous lines: "Newton was not the first of the age of reason. He was the last of the magicians … ."

The received image of Newton the Sage of Reason was perfected after he left Cambridge in 1696 to become Warden of the Royal Mint. As Master of the Mint from 1699 onward he was a powerful, active, and very successful civil servant. For twenty-four years he was also the reigning monarch of the Royal Society (to which he had been elected

Fellow in 1672). He was the first scientist to be knighted, in 1705. In his home in London – of which his brilliant and charming niece Catherine Barton was hostess (Newton never married) – he received the greatest intellectuals of Europe. Alexander Pope wrote Newton's epitaph when he died:

> "*Nature and Nature's laws lay hid by night:*
> *God said Let Newton be! and all was light.*"

Newton was buried in Westminster Abbey. The pall bearers to this farmer's son were three earls, two dukes, and the Lord Chancellor; they were followed by the Fellows of the Royal Society. The rather elaborate monument at his grave bears the inscription "*Hic depositum est, quod mortale fuit Isaaci Newtoni*." The immortal remains of Isaac Newton cannot be so neatly contained. Pope's anodyne epitaph speaks only of Newton the master of self-consistent natural philosophy. Yet this reasonable Newton was only a part of, and perhaps a result of, a complex and contradictory creature whose measure we cannot easily take. Perhaps a more appropriate epitaph to Newton would be the defiant words of the mystical American poet Walt Whitman in *Song of Myself*: "Do I contradict myself? Very well, then, I contradict myself. I am large, I contain multitudes."

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Isaac Newton and the Royal Mint

Isaac Newton began to seek public office by 1690, and there was a glimmer of hope when Charles Montague, a former student and a close friend of Newton, was apointed Chancellor of the Exchequer in late 1695. On 19th March of 1696, he wrote to Newton that at last he could give 'a good proof of my friendship' with the offer of the post of Warden of the Mint' which was worth approximately 500 pounds a year. Montague also informed that the office 'has not too much bus'neese to require more attendance than you may spare'. Earlier wardens, Newton was informed, 'came very seldom to the place

and did not do anything of service more than to come and ask how the affairs of the Mint were.' It was uncharacteristic of Isaac Newton, however, to take anything less than seriously, and he found himself caught up in one of the most dramatic events in the history of British coinage.

Before the middle of the 17th century, British coins were produced by hammering a die. From the time of Charles II, however, a machine was used which not only produced a clear impression but added a milled edge to the coins. Both hammered and milled coins were allowed to circulate. But the old coins, without a clearly defined edge, were easy to clip and counterfeit, and over the years their reliability became suspect. No one would willingly give a full-weight milled coin if one could pass instead a hammered coin with much less silver in it. Consequently, the milled coins became practically reserved for illegal activities and melting pot and the hammered coins bore the burden of mass circulation. A committee was formed in 1695 comprising scholars such as John Locke, Christopher Wren and Newton, to advise the government on this matter of grave concern, and the committee recommended recoinage. After Newton's appointment as the Warden, he supervised the entire operation of recoinage with an efficiency that befitted him.

As Warden, part of Newton's duties was the detection, capture and prosecution of counterfeiters. Earlier Wardens had left this job to clerks, but Newton, unwilling to delegate and incapable of taking his duties lightly, undertook the supervision himself. He frequented taverns to take depositions, came to know the prisons and interrogated several hundred people. Under his regime, twenty seven criminals were executed in 1697/98. Pleas of mercy did not seem to move him. (Some biographers (such as Frank Manuel) have even argued that the work allowed Newton 'to rage at prisoners and their wives and mistresses with impunity' and it was of therapeutic value as it allowed the release of the rage inside him.)

In 1700 he was appointed the Master of the Mint, a position he held until his death.

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