NEWTON: SCIENTIST AND MAN

By PROF. S. BRODETSKY

ISAAC NEWTON was born on Christmas Day, 1642; he died on March 20, 1727. His life extended over one of the most significant and exciting periods in British history. When he attended the small village schools near Woolsthorpe in south-west Lincolnshire, Parliament gained its victory over King Charles I. When, as a boy of fifteen, he disappointed his mother's desire that he should administer the modest paternal farm, Cromwell died. When he returned to the Grantham School in order to prepare to go to Cambridge, and was passing through what was his only and unsuccessful romantic episode, the merry monarch King Charles II was restored. The Royal Society was founded when he was a young Fellow of Trinity. When at the age of forty-four his "Principia" was going through the press, he represented the University of Cambridge in its struggle against King James II. He refused to entertain any question of compromise, and approved of the revolution of 1688, for he represented the University as a Whig in the Convention Parliament of 1691. Although he took no part in the debates, for he was a very indifferent speaker and easily embarrassed when expected to make any statement unprepared, he played a considerable part in adjusting the relations between his University and King William III and Queen Mary. It was in the days of Queen Anne that he became the acknowledged representative of English science and received a knighthood. His death in 1727 was followed by the death of King George I, the first of that series of monarchs under whom British democracy was established.

From his graduation in 1665 until March 1696—a period of thirty-one years—Newton devoted himself to a career of scientific discovery which has not been equalled by any other human being. In 1696 he went to London at the invitation of his young Cambridge friend, Charles Montague, who had become Chancellor of the Exchequer, in order to act as Warden of the Mint, and for another thirty-one years he lived in the midst of national affairs. There has been a theory that between his great academic career and his London life Newton had gone through a serious illness involving mental derangement. There is no evidence that his mind was ever affected, although for a time he needed very careful attention.

During the second part of his life Newton retained his full mental vigour, and often carried out difficult mathematical investigations with great success. But it seems that he had lost interest in scientific discovery as such. There is no doubt that the services that Newton rendered to the nation in helping to improve the currency were of considerable importance; but having done this with success and achieved the reward of being appointed Master of the Mint—a semi-gentlemanly position with a large salary and small responsibility—he resigned his chair at the University of Cambridge and was very happy to be the doyen of British science for the remainder of his life.

As a young man Newton possessed two great passions—the love of calculation and the love of experiment. He evidently considered himself to be

an experimentalist rather than a theoretical thinker. He devoted very long periods of time to laborious and complicated chemical experiments which led to no serious results. The fact that the man who established the mechanical method on which science has been based for two-and-a-half centuries was so intensely interested in the work of the alchemists of the Middle Ages, and devoted so much attention to the problem of converting base metals into gold, is an interesting illustration of the transition from the science of the Middle Ages to the new era inaugurated by himself: an era of unparalleled triumph in the mechanical interpretation of Nature, the philosophic foundations of which are only being questioned in our own day through the work of Einstein and the new quantum theory, based upon phenomena in the very large and the very small, far beyond any experimental evidence available until more than two centuries after the "Principia" was written.

Newton's aim seems to have been to explain natural phenomena in terms of forces acting on matter, and on the whole he refrained from framing explanations concerning the matter and the forces that he assumed in his work. His famous statement *hypotheses non fingo* was used when he defended himself against Leibniz's accusation that in his law of gravitation he had introduced occult methods into science and taught views contrary to a true belief in God, and really amounted to saying that his task was to explain under what laws things happened in Nature, and that he did not try to deal with the ultimate issues of the universe.

Newton's scientific work consisted of three parts: the optical, the mathematical, and the astronomical. It is scarcely necessary to explain what a remarkable achievement this work represented. It is sufficient to summarize the contents of the "Principia". This is not a text-book of existing knowledge with original additions here and there: it is one of the most original books ever written. The Galileo-Newton laws of mechanics are here formulated for the first time; the mathematical ideas required in the arguments, equivalent to the calculus, without which modern mathematics is unthinkable, are those invented by the author himself; the force of universal gravitation, invoked to explain the heavenly motions, is postulated as the result of Newton's own intuition; the study of fluid motions is initiated in order to dispose of the Cartesian hypothesis of heavenly vortices—the prevalent view held by all scientific men then; the phenomena explained in the "Principia" had never been in any sense satisfactorily explained before; the problems initiated, like lunar theory, planetary theory, shapes of planets, comets, tides, precession, etc., have occupied the best minds of humanity for centuries; the results achieved have been the admiration and inspiration of hundreds of mathematicians and astronomers, and will continue to be so for many centuries to come—and with it all there is a spirit of simplicity, dignity, sanity and soberness, and a grandeur of conception, that place Newton and his work on an unequalled level of eminence.

We are now living in a time when youth is "coming into its own"; often it is misled into hopeless misery. But youth is a characteristic of scientific progress. Einstein once said: "A person who has not made his great contribution to science before the age of thirty will never do so". This was abundantly true of Newton. His three contributions to knowledge—the spectrum, fluxions, and gravitation—were developing when he was a young man of twenty-three. The plague of 1665 drove Newton to his Lincolnshire home, and for a year or two he was more or less cut off from scientific contacts; but many notes made then testify to the growth of these ideas in his mind.

It is unimaginable that one person could have done all that Newton achieved, working alone without help or co-operation from others, interrupting his work by brief and no doubt almost unintelligible lectures, getting his recreation by walking in the little garden that was attached to his rooms at Trinity College, and often spending weeks on futile chemical experiments searching for something in the constitution of matter which he never understood, and which was quite beyond the understanding of those days. Few mathematicians or astronomers have read the "Principia": it is a unique experience to follow Newton's awe-inspiring genius in the original. It is a similar experience to read his "Opticks", and to think that the man who invented these remarkable experiments, leading on by unimpeachable logic to that which laid the foundation of so much of the physics, chemistry, astronomy and technology of the nineteenth and twentieth centuries, was at the same time almost in secrecy evolving new and revolutionary mathematical methods on which he based the "Principia".

Newton had done his work by the time he was forty-four. It is true that he published his "Opticks" when he was sixty-one, but the book largely represented his youthful work. He published later editions of the "Principia", and he made efforts from time to time to deal with lunar theory, but later workers built up systems, planetary and lunar, of which he dreamt. One can easily conceive the whole of Newton's scientific work after the "Principia" eliminated, without in any way affecting the place that he occupies in scientific history.

Newton spent much energy on non-scientific problems. He refused to take Holy Orders in order to retain his fellowship at Trinity, and got special permission from King Charles II to retain his fellowship while remaining a layman. This was not due to light caprice or indifference. Newton was deeply interested in theological philosophy. He had a thorough knowledge of the Bible; he recorded his views about God and Christ, and even attempted to publish—outside England—statements which implied doubts concerning fundamentals of the accepted faith. He was inclined to mystical views. But he was an anti-Catholic and not quite clear about the nature of miracles. He made a very clear distinction between human rights and divine sanction. It was Newton who wrote: "The authority of emperors, kings and princes, is human; the authority of councils, synods, bishops and presbyters, is human; the authority of the prophets is divine". He fought against royal attempts to exercise unlimited authority. He went to Parliament on two occasions as a confirmed Whig, and was a keen opponent of anything which gave to human beings powers that could only be attributed to the divine. It is difficult to compare political views in different periods, but it is not incorrect to suggest

that Newton was what we would call to-day an advanced Liberal.

There is a fine streak in Newton's character, showing the immortal scientist behaving with the greatest care and kindness to young men in whom he saw signs of ability or genius. He was especially friendly with Halley, no doubt in gratitude for the way in which Halley carried the financial as well as the editorial responsibilities in the publication of the "Principia"; he was kind and appreciative of Roger Cotes, Colin Maclaurin, James Stirling; he supported the peculiar William Whiston. Newton was very generous even when he was not wealthy. He remained the owner of his small hereditary estate in Lincolnshire, and some of his letters indicate his intense interest in such minor matters as the inhabitability of cottages and the comfort of his tenants.

But Newton's life was spoilt by a series of quarrels with some of the most brilliant men of his time. Even as a young man he could not stand criticism of his scientific work, and announced that he would not publish anything at all if he had to be a "slave to philosophy" and spend his time answering criticisms. It seems that this was why he became an open enemy of that erratic genius Robert Hooke. John Locke described him as "a nice man to deal with", with the Shakespearian meaning of "nice". He had persistent quarrels with John Flamsteed, that brilliant, poor and modest first Astronomer Royal, who had to earn his living as a vicar as well as by private teaching, and who helped Newton with information for the "Principia" and for his efforts on lunar theory. Newton seems to have been a rather unworthy participant in the great controversy with Leibniz and John Bernoulli concerning priority in the discovery of the method of the calculus. These quarrels throw a peculiar light on his personal and scientific character, unworthy of a great thinker. He even wanted to leave the astronomical part of the "Principia" unwritten in case it was subjected to criticism. It seems that in his Cambridge life Newton wanted to be free from all discussion, so as to work privately and uninterruptedly on some things that were useless, and on some which form the glory of human discovery. When he was the public man in London he seemed to possess an extraordinary belief in his own achievements, and treated some other people in a way unworthy of a leader of science.

Newton made some serious mistakes in his scientific work. His optical ideas held up the development of the achromatic telescope, and were an obstacle to the evolution of the wave theory of light. It seems that his primitive theories on fluid resistance kept some people in our own generation dubious of the possibility of flight. Would he himself have disapproved of slavish subservience to his own authority?

One may be doubtful of this, but such was Isaac Newton, endowed with unimaginable mental qualities and with obvious faults; the down-at-heel professional bachelor of his academic days, and the rather wealthy Court favourite of his later years; the man who believed in freedom, who fought the tyranny of a king, and in his own way helped to develop British democracy. Newton was not a statesman or a politician. He was not technically a philosopher. He never recorded any social theory. But it is well to-day to remember him not only as the man who made the heavens intelligible to humanity, but also as a man who helped to give liberty to humanity so that it may be free to look up into heaven.