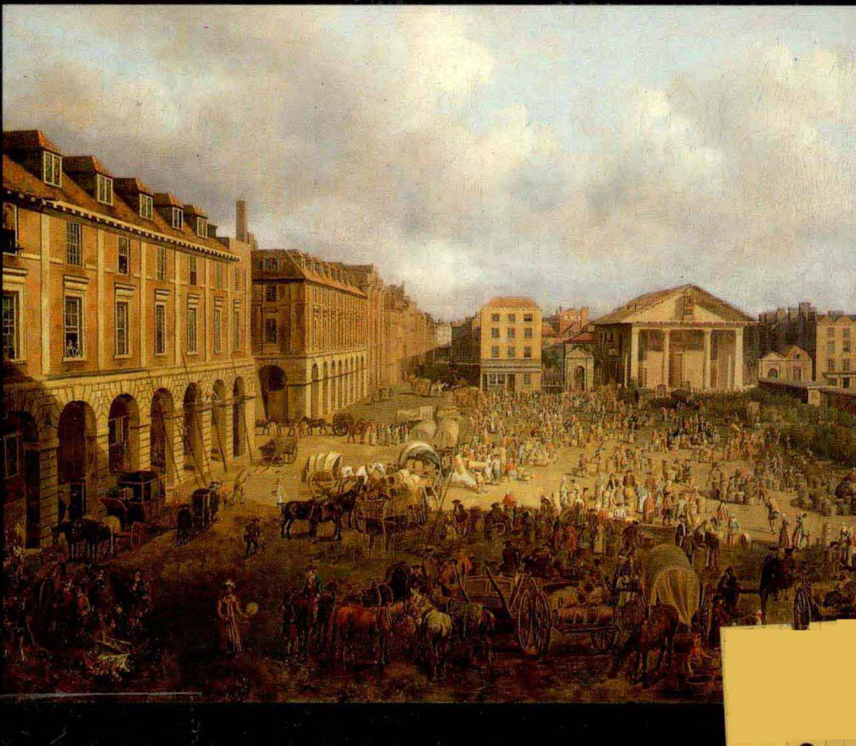
Second Edition

The Eighteenth Century
The Intellectual and Cultural Context of English Literature 1700–1789

James Sambrook



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The Eighteenth Century

THE INTELLECTUAL AND
CULTURAL CONTEXT OF
ENGLISH LITERATURE
1700 – 1789

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James Sambrook

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Chapter 1
Science

The last edition of Johnson's *Dictionary* published in our period defines the word 'science' as 'knowledge', 'certainty grounded on demonstration', 'art attained by precepts, or built on principles', 'any art or species of knowledge', and 'one of the seven liberal arts'. Though the old liberal arts included arithmetic, geometry, and astronomy, and though the second of Johnson's definitions points towards later semantic developments, it was not until long after the great lexicographer's death that 'science' became synonymous with what he would have referred to as 'natural philosophy'. Nevertheless, the process by which science (in the modern sense) came to be regarded as the truest form of knowledge and its system became the model for other systems of knowledge was well under way in the eighteenth century. It was then that most educated men incorporated the most accessible discoveries of the previous century, the age of Galileo, Kepler, and Newton, into their ordinary view of the physical world.

The realization that the earth was a lesser planet of one relatively unimportant star among millions proved to be less chastening than one might expect; its most widespread effect was to encourage confidence in the sublime capacity of the human mind and in the power of scientific method. If men were excited by the vastness and order of the universe they were no less excited by the fact that human intelligence could formulate the laws which governed the motions, relations, and physical properties of that universe. Science gave new freedom and new hope, as if mental and stellar horizons were expanding together: the sudden and huge growth of ordered and apparently certain knowledge seemed greatly to enlarge the possibilities of intellectual, moral, and practical improvements. Increasing knowledge of the heavenly system provided demonstrations of the power and wisdom of God, and supplied practical aids to navigation; increasing knowledge of the physical and chemical properties of matter provided further demonstrations of the power and wisdom of God, and brought about improvements in manufacturing industry: the Steam Age dawned. At the same time, increasing knowledge of the physical world made the hypothesis of a God unnecessary for some men. Encouraged by the successes of experimental science in general, and supported by increasing knowledge of optics and physiology, philosophers for a while came to believe that they, too, might be able to discover natural laws which would make their conclusions and predictions as reliable as those of the scientists. Though philosophy was not transformed into the hoped-for science of mind, the investigations of eighteenth-century philosophers into perception, sensibility, and imagination were of incalculable value to poets, novelists, and critics.

For poets, philosophers, and theologians, as well as for other scientists, the great intellectual hero of the eighteenth century was Sir Isaac Newton (1642–1727), 'the Miracle of the present Age' as Addison called him (*Spectator*, no. 543). Of course the modern scientific revolution was under way before Newton was born; scientific enquiry was organized in the Royal Society before he was heard of; his great synthesis was based in considerable part upon the researches of Boyle, Barrow, Hooke, Flamsteed, and Wallis, as well as upon those of Continental natural philosophers such as Descartes, Galileo, Kepler, and Huyghens; but for eighteenth-century Englishmen scientific advance was to a remarkable extent identified with the single name of Newton. The triumph of mind represented by his work had an awe-inspiring, elemental, universal quality which seemed comparable with Nature itself. As Pope's famous couplet makes clear, Newton personified enlightenment.

> Nature and Nature's Laws lay hid in Night;
> God said Let Newton be! and all was Light.

(Pope's compliment was particularly apt in view of Newton's discovery that all the colours are contained in white light, a discovery that delighted several generations of poets.)[1]

The blaze of new scientific knowledge which glorified Newton's name was generated by a union of empirical observation with mathematical method. The title of his great book is *Philosophiae Naturalis Principia Mathematica*, the mathematical principles of natural philosophy (i.e. science); in its Preface, dated 8 May 1686, Newton writes: 'I have in this treatise cultivated mathematics as far as it relates to philosophy.' His method is to deduce mathematical formulae from the observed motions of bodies in the heavens and on earth, and then from these formulae to deduce other motions which could be checked against further observations: 'for the whole burden of philosophy seems to consist in this – from the phenomena of motions to investigate the forces of nature, and then from these forces to demonstrate the other phenomena'.[2] Thus Newton applied his principles of motion to account for many hitherto unexplained natural phenomena, such as perturbations in the moon's orbit, the rise and fall of tides, and the behaviour of light. He was able to show by his calculations, for instance, that comets were not mysterious, haphazard, or new-created phenomena, but subject to the same law of gravitation as the planets; thus enabling Edmund Halley to plot, in 1682, the orbit of the comet that bears his name, and to prophesy its return in 1758.

In one aspect Newton's achievement was the consolidation of that seventeenth-century intellectual revolution, begun by Bacon, which almost banished metaphysics and mystery from the natural sciences; in another it was prophetic of continuing revolutions as inevitable as the return of a comet. Instead of deducing knowledge of particular phenomena from general a priori assumptions about whole systems, scientists and, increasingly after Newton, other thinkers followed the practice of ascending gradually from observation and experiment, by way of analysis, towards general theories. The process of analysis was unending: general principles, even Newton's principle of gravitation, could never be other than provisional. Indeed, Newton himself was aware of certain irregularities in the movements of celestial bodies which could not be accounted for by his laws of motion, and believed that the cumulative effect of such irregularities would be to destroy the equilibrium of the solar system if God did not intervene at long intervals to set the system to rights. Later generations of astronomers and mathematicians, down to Pierre Simon Laplace (1749–1827), were able to offer naturalistic explanations of these irregularities, and so confirm the accuracy of Newtonian principles in their non-metaphysical aspect, with the result that no large-scale revision was called for until the Einstein era.

Though Newton's principles were rapidly accepted in Britain, they were resisted in some quarters on the Continent, particularly in France, where the system of Descartes set out in *Principia Philosophiae* (1644) was accepted by most philosophers until almost the middle of the eighteenth century. The concept of gravitation, a force acting at a distance across apparently empty space, seemed absurd to mechanical philosophers who believed that bodies could move only when pushed. In the opinion of Descartes, for instance, the planets were moved by the pressure of ether in a solar vortex. Newton was able to demonstrate conclusively that such a hypothesis could not account for the motions actually observed, whereas his own principle of gravitation could.

He was cautious in ascribing a mechanism to universal gravitation. In the *General Scholium* which he added to the second edition of his *Principia* in 1713 he wrote:

> I have not been able to discover the cause of those properties of gravity from phenomena, and I [feign] no hypotheses; for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical,

whether of occult qualities or mechanical, have no place in experimental philosophy. . . . And to us it is enough that gravity does really exist, and acts according to laws which we have explained, and abundantly serves to account for all the motions of the celestial bodies, and of our sea.

Nevertheless, in the concluding paragraph of the *General Scholium* he speculated that 'a most subtle spirit', accounted both for gravitation and for the chemical structure and some physical properties of matter:

We might add something concerning a most subtle spirit which pervades and lies hid in all gross bodies; by the force and action of which spirit the particles of bodies attract one another at near distances, and cohere, if contiguous; and electric bodies operate to greater distances . . .; and light is emitted, reflected, inflected, and heats bodies; and all sensation is excited, and the members of animal bodies move at the command of the will.[3]

Newton privately pursued the 'subtle spirit' through his extensive reading of old alchemical writings, his discussions with the great modern chemist Robert Boyle, and his own chemical experiments in the laboratory he built in his Cambridge garden. He devoted much time and intellectual energy to alchemy and chemistry but published nothing on either study beyond a query in his *Opticks* (1704), suggesting that there might be agents in nature 'able to make the Particles of Bodies stick together by very strong Attractions' and that it would be the business of experimental philosophy 'to find them out' (query 31). Independent of such speculation, gravitation worked. The investigations of astronomers, physicists, and mathematicians in England and Europe throughout the eighteenth century all bore witness that the principle of gravitation, that every body attracts every other body with a force proportional to its mass and inversely proportional to the square of the distance between them, is as comprehensive as it is simple. Newton himself declares that Nature 'will be very conformable to her self and very simple'[4]; so a single formula can account at once for the fall of a pebble and the movements of the stars. The principle of gravitation, a particularly cogent expression of unity in variety, seized the imagination of men as fully as it satisfied their understanding.

Newton's second great success, the development of a calculus method, was of great value to the evolution of mathematics and therefore to science in general; it was applauded by Englishmen in the eighteenth century, if only because of the nationalistic passions aroused by the shameful priority dispute between Newton and Leibniz[5]; but it did not influence the wider intellectual life of eighteenth-century Britain nearly as obviously as did his theory of celestial mechanics, or his third great achievement, the theories concerning light which were eventually published in *Opticks*.

The figure of 'Newton with his prism' caught the imagination of Englishmen some generations before Wordsworth. In a paper read to the Royal Society early in 1672 Newton described the first of a series of famous experiments in his makeshift camera obscura:

> having darkened my chamber, and made a small hole in my window-slits, to let in a convenient quantity of the Sun's light, I placed my Prisme at his entrance, that it might be thereby refracted to the opposite wall. It was at first a very pleasing divertisement, to view the vivid and intense colours produced thereby; but after a while applying my self to consider them more circumspectly, I became surprised to see them in an *oblong* form; which, according to the received laws of Refraction I expected should have been circular.[6]

This oblong form was the effect of light of different colours being refracted through different angles, for, as Newton's further experiments demonstrated, white light was a mixture of many colours. Men accepted so revolutionary a notion rather slowly, but when they did it seemed that a new world of Nature was revealed. James Thomson conveys the excitement of this discovery in *A Poem sacred to the Memory of Sir Isaac Newton* (1727), when he praises the great scientist for untwisting 'all the shining Robe of Day', and exclaims:

> Did ever Poet image aught so fair,
> Dreaming in whispering Groves, by the hoarse Brook!
> Or Prophet, to whose Rapture Heaven descends!

Newton does not claim to know more about the mechanism of colour than he does of gravitation. Both are known by their effects:

> if at any time I speak of Light and Rays as coloured or endued with Colours, I would be understood to speak not philosophically and properly, but grossly, and accordingly to such Conceptions as vulgar People in seeing all these Experiments would be apt to frame. For the Rays to speak properly are not coloured. In them there is nothing else than a certain Power and Disposition to stir up a Sensation of this or that Colour. For as Sound in a Bell or musical String, or other sounding Body, is nothing but a trembling Motion, and in the Air nothing but that Motion propagated from the Object, and in the Sensorium 'tis a Sense of that Motion under the Form of Sound; so Colours in the Object are nothing but a Disposition

> to reflect this or that sort of Rays more copiously than the rest; in the Rays they are nothing but their Dispositions to propagate this or that Motion into the Sensorium, and in the Sensorium they are Sensations of those Motions under the Forms of Colours.[7]

The sensorium is that part of the brain where nerves terminate. Just as Newton's celestial mechanics rests upon the presuppositions that time and space are absolute and that matter is particulate, his science of optics rests upon certain assumptions concerning the physiology of perception, assumptions made explicit in Locke's distinction between primary and secondary qualities (see p. 62 below) and which the joint authority of Newton and Locke was to make highly influential throughout the eighteenth century. Such assumptions are made clearer in the speculative queries added by Newton to successive editions of the *Opticks* between 1704 and 1718: those queries which, after the *General Scholium* of the *Principia*, proved to be the writings of his most accessible to the understanding of non-scientists.

The queries as expanded and revised in 1718 constituted Newton's last notable publication. Though they were put forward ostensibly as a programme of possible future research by other natural philosophers, they were accepted, not unreasonably, by most of his readers as statements of his considered convictions about the ultimate nature of things. In their final form they reintroduce and elaborate Newton's concept of the ether as it appeared in the *General Scholium* to the *Principia*. This expanded, tenuous fluid medium which extends throughout the entire universe, and which in a more subtle and rarefied state pervades the pores of bodies, accounts for gravity and for magnetism and (static) electricity: 'If any one would ask how a Medium can be so rare, let him tell me how . . . the Effluvia of a Magnet can be so rare and subtile, as to pass through a Plate of Glass without any Resistance or Diminution of their Force, and yet so potent as to turn a magnetick Needle beyong the Glass?' Taking up the theory of the Dutch philosopher Christian Huyghens that light is a pulse or 'pression' in the ether, Newton suggests that his hypothetical ethereal medium also accounts for the mechanics of vision, and perhaps for hearing and the other senses:

> Is not Vision perform'd chiefly by the Vibrations of this Medium, excited in the bottom of the Eye by the Rays of Light, and propagated through the solid, pellucid and uniform Capillamenta of the optick Nerves into the place of Sensation? And is not Hearing perform'd by the Vibrations either of this or some other Medium, excited in the auditory Nerves by the Tremors of the Air, and propagated through the solid, pellucid

> and uniform Capillamenta of those Nerves into the place of Sensation? And so of the other Senses.

The ethereal medium accounts also for bodily motions: 'Is not Animal Motion perform'd by the Vibrations of this Medium, excited in the Brain by the power of the Will, and propagated from thence through the solid, pellucid and uniform Capillamenta of the Nerves into the Muscles, for contracting and dilating them?'[8]

There is no significance in the fact that a First Cause is not introduced to account for those mechanical causes discussed in the queries about ether which Newton added to the 1718 edition. Those queries which he allowed to stand from earlier editions state his often-repeated opinion that 'the main Business of natural Philosophy is to argue from Phaenomena without feigning Hypotheses, and to deduce Causes from Effects, till we come to the very first Cause, which certainly is not mechanical'. The important questions to be answered are modern restatements of those put by God to Job: 'Whence is it that Nature doth nothing in vain; and whence arises all that Order and Beauty which we see in the World? To what end are Comets. . . .? . . . How came the Bodies of Animals to be contrived with so much Art, and for what ends were their several Parts?'[9]

Newton's discoveries and conjectures were most highly valued by his contemporaries because they satisfied feelings of religious awe and devotion, and seemed to offer rational grounds for a belief in God. They were repeatedly employed by scientists, divines, essayists, and poets to reinforce a traditional physico-theological argument which was intended to demonstrate the existence and benevolent attributes of God on the evidence of the created universe: see pp. 35–8 below. Newton shared the religious certainty of most of his contemporaries. The famous passage from the *General Scholium* to the *Principia* (quoted above), where Newton repudiates hypotheses, follows some very unequivocal hypotheses:

> This most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being. . . . Since every particle of space is *always*, and every indivisible moment of duration is *everywhere*, certainly the Maker and Lord of all things cannot be *never* and *nowhere*. . . . He is omnipresent not *virtually* only, but also *substantially*; for virtue cannot subsist without substance. In him are all things contained and moved; yet neither affects the other: God suffers nothing from the motion of bodies; bodies find no resistance from the omnipresence of God. It is allowed by all that the Supreme God exists necessarily; and by the same necessity he exists *always* and *everywhere*.[10]

Like most of his contemporaries, Newton accepts the old Stoic conception of the universe as a finite world surrounded by infinite space: 'we cannot imagine any limit anywhere without at the same time imagining that there is space beyond it'. Though we cannot imagine infinity we can understand it, because we can understand 'that there exists a greater extension than any we can imagine'.[11]

According to the *General Scholium*, God is omnipresent in space not figuratively but literally: infinite space is an attribute of God. There is a bolder hypothesis in some of the queries added to the 1706 Latin edition of the *Opticks*, and retained as the climax and conclusion to that treatise as Newton left it in 1718. In query 28 he writes: 'Is not infinite Space the Sensorium of a Being incorporeal, living, and intelligent, who sees the things themselves intimately, and thoroughly perceives them, and comprehends them wholly by their immediate presence to himself: Of which things the Images only carried through the Organs of Sense into our little Sensoriums, are there seen and beheld by that which in us perceives and thinks?' That Newton may have had some misgivings over this conjecture appears from a correction in the 1718 edition, first printed as a cancel in some copies of 1706, whereby the literal sensorium of God is transformed into a figurative one: 'does it not appear from Phaenomena that there is a Being incorporeal, living, intelligent, omnipresent, who in infinite Space, as it were in his Sensory, sees the things themselves', etc. The literal divine sensorium remains, however, in query 31 of the 1718 edition, where Newton asks whether the system of Nature can be other than the effect of 'the Wisdom and Skill of a powerful ever-living Agent, who being in all Places, is more able by his Will to move the Bodies within his boundless uniform Sensorium . . . than we are by our Will to move the Parts of our own bodies'.[12]

Newton's speculations on interstellar space and on human vision come to rest in the notion of the infinite divine sensorium and its bounded human analogue, the point of interaction between mind and matter, object and subject. His business finally is with the problem of perception, which so exercised the minds of eighteenth-century philosophers. However forbidding the mathematics, his vision of a universe in which every act of human perception and every motion of countless suns and planets is a vibration in the ether, his revelation of a maze of colour hidden within the light of common day, and his heroic binding of the suns and planets to their orbits created wonder and excitement among his non-scientist readers. Whatever Blake and Keats might think. Newton's achievements and speculations were, for most of the eighteenth century, the stuff of religion and poetry.

In the *Spectator*, no. 565 (9 July 1714) Addison looks up to the infinite host of stars, 'or, to speak more Philosophically, of Suns', remembers that Huyghens had speculated on the likelihood that 'there may be

Stars whose Light is not yet travelled down to us, since their first Creation', refers to Job and the Psalmist on the insignificance of man, and is reduced to a state of 'secret Horror'. The horror is duly dispelled, though, when he recollects Newton's 'noblest and most exalted' conception of infinite space as God's sensorium; there could be no doubt that God had cognizance of Joseph Addison. Many in the nineteenth century were dismayed by what they saw as the cold emptiness of interstellar space, but throughout the eighteenth century most thinking Englishmen were comforted and exalted, much as Addison was.

Addison was only one of the more influential popularizers of Newton; others of equal or greater importance included the Boyle lecturers (see p. 37 below) and, following rather a different direction, Voltaire. A less philosophical influence was exercised by a work such as *Il Newtonianismo per le Dame* (1737), which was Newton's *Opticks* simplified for the understanding of ladies by Francesco Algarotti, a not altogether respectable ladies' man. At a lower social level, the popular diffusion of Newtonian science was continued through literally dozens of compilations produced between the 1730s and 1780s by the self-educated quondam ploughboy and instrument-maker Benjamin Martin (1704–82). More representative perhaps is the contribution of John Theophilus Desaguliers (1683–1744), one of a group of Newton's devoted disciples in the Royal Society who broadcast their master's principles in a shower of popular textbooks and learned papers. Desaguliers lectured on the Newtonian system of optics and mechanics at his house in Westminster from 1712 and later at a coffee-house in Covent Garden, being the first of many distinguished learned men in that century to give lectures on scientific topics to the general, non-academic public. His allegorical poem, *The Newtonian System of the World, the best Model of Government* (1728), was an early example of the many attempts in that century to apply Newtonian principles to non-scientific fields of intellectual endeavour.

At this period much scientific research was still well within the comprehension of most educated men: from its early years the Royal Society (founded 1662) had included literary figures and men of affairs among its members; throughout the eighteenth-century the most widely-read periodicals regularly contained news of scientific discoveries and discussion of their effects upon general intellectual life. Museums were established: notably the Ashmolean at Oxford in 1683 and the British Museum in 1759, the latter based on the collection of Sir Hans Sloane, botanist, President of the Royal Society, and physician to George II. Other large and well-known private scientific collections were built up by the anatomist William Hunter (1718–83) and his brother John (1728–93), the surgeon: these collections eventually came into the possession of, respectively, the University of Glasgow and the Royal College of Surgeons; both were teaching aids for practitioners in what was defining itself at this time as the medical profession. John Hunter arranged the animal and vegetable specimens in his museum 'by function – motor apparatus, digestive and sensory organs, reproductive parts, and so on – "each series ranging the evolutionary scale from the simplest mechanisms to the most complex," a thematic emphasis which anticipated a basic principle of modern educational museology'.[13] For the less learned there were collections of curiosities such as the one at Don Saltero's coffee-house in Chelsea, satirized in Richard Steele's *Tatler* 34 (28 June 1709) and mentioned approvingly in Chapter 69 of Smollett's *Peregrine Pickle* (1751). Descending lower, the long-popular freak and animal shows at Bartholomew Fair and other places of traditional popular resort were now sometimes advertised as 'philosophical curiosities": not unnaturally, in view of the fact that fairground 'monsters' were from time to time the subject of learned papers in the *Philosophical Transactions* of the Royal Society. That was the case, for instance, of a pair of what today would be called Siamese twins who were exhibited at the Angel Inn, Cornhill, in 1708. Jonathan Swift noted that this show 'causes a great many speculations; and raises abundance of questions in divinity, law, and physic'.[14]

Demonstrations of scientific experiments reached a wider public during the course of the century. The first complicated scientific instrument intended as a teaching aid rather than a research tool was designed about 1700 by George Graham: it was a portable planetarium, a machine for exhibiting the motions of the planets in their orbits around the sun by means of globes, slender rods, and wheels. The copy of the machine made by John Rowley was called an 'orrery' in honour of Rowley's patron, Charles Boyle, fourth Earl of Orrery; it was under this name that Steele described the machine in the *Englishman* no. 11 (29 October 1713). According to Steele, 'it is like receiving a new Sense to admit into one's Imagination all that this Invention presents to it. . . . It administers the Pleasure of Science to any one.' Steele's essay brings out something of the wonder and delight aroused in ordinary people by demonstrations of science; but a far more vivid effect is achieved in the masterly painting by Joseph Wright of Derby, *A Philosopher giving that Lecture on the Orrery in which a Lamp is put in the place of the Sun* (1766): see Plate 13. In this painting the philosopher is a dominating figure, casting a huge shadow; he pauses as the young man on the left takes notes; all the others, including the painter himself on the right, are raptly attentive. The elliptical metal bands of the orrery and the faces of the onlookers catch the light which emanates from the lamp, thus dramatizing not only the power of the sun to bring into view and, as it were, 'create' a planet or a