# Cambridge Scientific Minds

*Edited by*

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# 1 William Gilbert

STEPHEN PUMFREY

> As for the causes of magnetic movements, referred to in the schools of philosophers to the four elements and to prime qualities, these we leave for roaches and moths to prey upon.
>
> Gilbert, *De Magnete*, Book II, Chapter 3.

The reputation of William Gilbert (1544–1603) as a great scientific mind traditionally rests on three foundations, all of which are evident in the only book he published, the seminal *De Magnete* [On the Loadstone] (London, 1600). First, he discovered that the Earth was a giant magnet and, in order to establish the fact, inaugurated the modern science of magnetism. Secondly, he rightly boasted that the method evident in *De Magnete* was experimental, a radical break with the more textual methods used by his scholastic contemporaries. Finally, he distinguished between magnetism and electricity, which had hitherto been paired as similar, occult attractive principles; he even coined the noun *electricitas*, which was rapidly Anglicised as 'electricity'. Gilbert has been made a hero as 'the first experimental scientist', and he would come first, chronologically, in many surveys of scientific minds, not just of Cambridge minds. In Cambridge, he is immortalised in the name of Gilbert Road, a development built on land belonging to his college, St John's. As a Cambridge schoolboy, I entered my primary school every day from Gilbert Road, regrettably ignorant of the existence of the eponymous scientific hero.

Nevertheless, Gilbert's inclusion in this collection is probably the most controversial. This is not because the extent of his fame in his lifetime was limited to be one of England's most eminent doctors, who rose to become President of the College of Physicians, and a royal physician to both Queen Elizabeth I and James I. There are three more profound reasons. First, like Sir Isaac Newton, he did not practice science.

As Peter Harman's introduction makes clear, our modern discipline came into existence two centuries later. Like Newton, Gilbert described himself as a natural philosopher, although Newton differed from him by emphasising the importance of mathematics and of clear methodological rules in the investigation of nature.

Secondly, some of Gilbert's central beliefs were decidedly prescientific. He held that the planets possessed some form of soul, the earth's being a magnetic one. He believed in divine cosmic harmonies, and he practised astrology. If these beliefs do not exclude Gilbert, we might consider the first Cambridge scientist to be Dr John Dee, graduate of St John's College in 1545, founding fellow of Trinity College, promotor of Euclidean geometry, and interrogator of angels.

Thirdly, like Francis Bacon, Gilbert's attitude to the academic values of Cambridge University, indeed of university natural philosophers everywhere, was hostile and dismissive – witness the quotation that begins this chapter. Gilbert would have agreed that his mind flourished only when he left the groves of academe for the cultural and economic dynamo of London, which in late Elizabethan times was the booming centre of an emerging imperial power.

Let us begin with a brief biographical portrait, and then focus on Gilbert's natural philosophical achievements, before concluding with his problematic relationship to Cambridge. He was born in Colchester, Essex in 1544, the eldest son of Jerome and Elizabeth. The Gilbert family came from merchants of relatively recent wealth, and Jerome benefited by gaining a university education and a profession – law. As the eldest son of middling pseudo-gentry, William was likewise prepared for a professional career, in the expanding field of medicine. He went up to St John's College in 1558 from Colchester Grammar School, and proceeded to a BA in 1561. He was admitted to a fellowship, and received his MA in 1564. To do so he probably lectured on Aristotle's physical works *De Caelo* and *Meteorologica*. He then studied for an MD, which was awarded in May 1569.

There are no signs that he was discontented with the academic world of Cambridge at this stage. Indeed he took on posts at St John's, becoming mathematical examiner in 1565 and 1566, and bursar in 1570. His only surviving books come from his time at St John's and they are perfectly traditional: two volumes of Galen, one of Aristotle's natural philosophy, and Matthioli's *materia medica*. There is no truth in the story that, because he had a low opinion of the Cambridge medical faculty, he took a medical degree abroad, as did William Harvey and other ambitious physicians. Gilbert's glittering, home-grown medical career was matched step-by-step by Harvey's father-in-law, his friend and fellow Johnian, Lancelot Browne.

There is then a gap in his *curriculum vitae*, because records of Gilbert's life and work are lacking. He died of the plague, and his effects were probably burned. Other papers and instruments that he bequeathed to the College of Physicians perished when the College, like his London residence, was destroyed in the Great Fire of 1666. The best guess is that, like many young physicians, Gilbert moved to London in order to build up a medical practice. He succeeded, and was already a Censor in the London College of Physicians in 1581, putting him near the apex of its forty-odd Fellows.

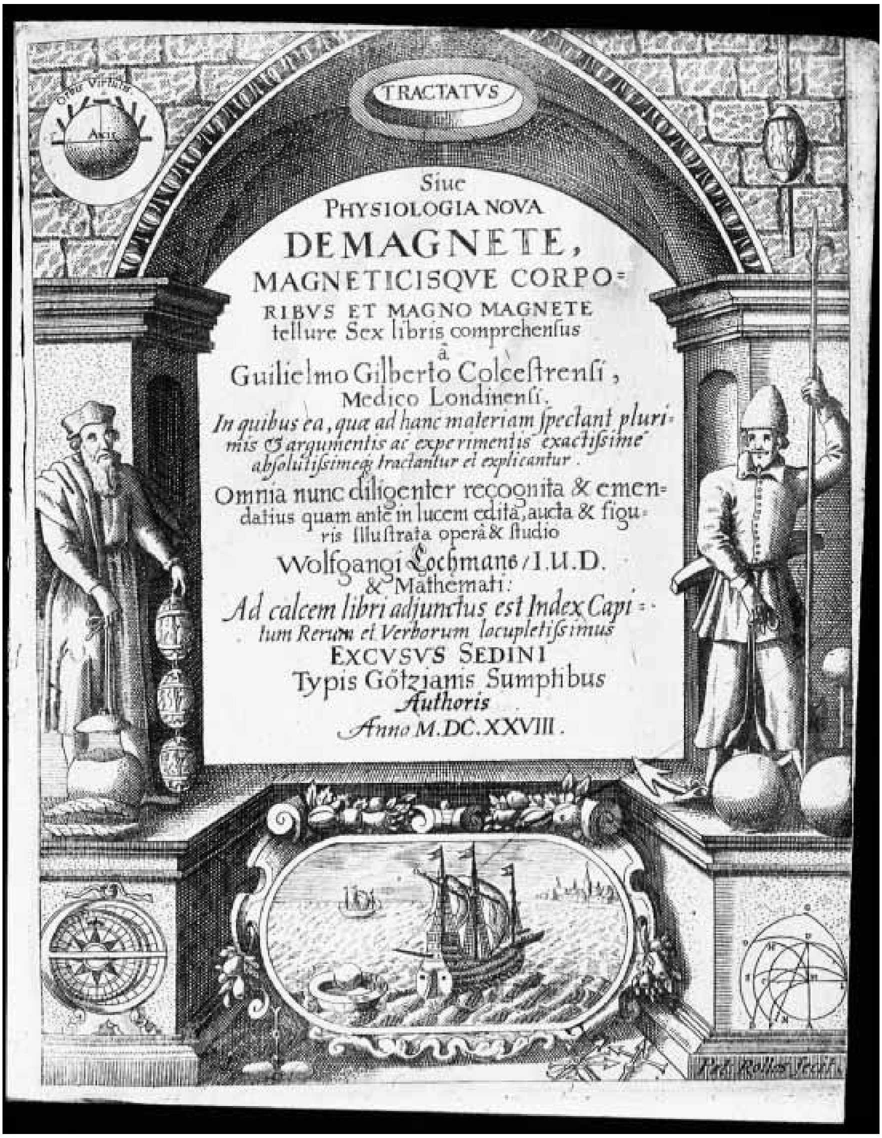
To become a royal physician required not only the College's backing but also that of powerful nobles. Gilbert had the best. By 1581 he was already a client of Robert Dudley, Earl of Leicester, and later served the family of William Cecil, Lord Burghley, amongst others. These patrons probably influenced not only Gilbert's medical, but also his natural philosophical career, because Leicester and Burghley patronised networks of mathematical practitioners, such as John Dee and Thomas Digges, directing them to military and naval research in the service of the state. Thus, three months prior to the defeat of the Spanish Armada, Gilbert (and Browne) were named as 'fytt persons to be employed in the said Navye to have care of the helthe of the noblemen, gentlemen and others in that service'.

Through courtly contacts, Gilbert got to meet and admire famous mariners, such as Sir Francis Drake and Sir Thomas Cavendish (England's first circumnavigator), and leading theorists of navigation, such as William Barlowe and, most influentially, Edward Wright. From these eminent Elizabethans, Gilbert learned about the importance of magnetic navigation using the compass, and became aware of the general lack of understanding of the compass and magnetism. Indeed, Edward Wright, once a fellow of Gonville and Caius but subsequently mathematician to the Earl of Cumberland, collaborated closely with Gilbert in the composition of *De Magnete*, Wright provided magnetic compass data, the latest navigational theories, and actually wrote parts of it.

Gilbert's book is infused with an empiricist rhetoric that pre-empted his younger courtier colleague Bacon. He insisted that those who worked with nature, like navigators, metallurgists, and farmers, understood more about the nature of the Earth, and earthly matter, than did professors of scholastic Aristotelian philosophy. It is, however, not plausible to assume that either a commitment to improve magnetic navigation, or an empiricist's determination to investigate the loadstone thoroughly, was sufficient motivation for Gilbert to devote (according to some sources) eighteen years and £5 000 in the preparation of a scientific work 'on the magnet'. That said, *De Magnete* was an unrivalled synthesis of past views (invariably criticised), reliable reports, and new experiments. Prior to *De Magnete*, the most exhaustive and empirical treatise had been *On the Loadstone*, which formed Book VII of the 1589 edition of Giambattista della Porta's *Natural Magic*. A flavour of Gilbert's experimentalism can be gained from his careful refutation of Porta's conclusion that an iron needle rubbed with diamond also points north.

> Now this is contrary to our magnetic rules; and hence we made the experiment ourselves with seventy-five diamonds [!] in the presence of many witnesses, employing a number of iron bars and pieces of wire, manipulating them with the greatest care while they floated in water, supported by corks; yet never was it granted to me to see the effect mentioned by Porta.

Recent historians have taken seriously Gilbert's cosmological beliefs as his prime motivation. His central philosophical dogma was



TRACTATVS
Siue
PHYSIOLOGIA NOVA
DE MAGNETE,
MAGNETICISQVE CORPO=
RIBVS ET MAGNO MAGNETE
tellure Sex libris comprehensus
à
Guilielmo Gilberto Colcestrensi,
Medico Londinensi.
*In quibus ea, quæ ad hanc materiam spectant pluri=
mis & argumentis ac experimentis exactissime
absolutissimeq; tractantur et explicantur.*
Omnia nunc diligenter recognita & emen=
datius quam antè in lucem edita, aucta & figu=
ris illustrata operâ & studio
Wolfgangi Lochmans / I.U.D.
& Mathemati:
*Ad calcem libri adiunctus est Index Capi=
tum Rerum et Verborum locupletissimus*
EXCVSVS SEDINI
Typis Götzianis Sumptibus
*Authoris*
*Anno* M.DC.XXVIII.

FIGURE 1.1 Title page of Dr William Gilbert's 1628 edition of De Magnete.
*Source:* The Whipple Library, University of Cambridge.

that the Earth was a noble part of the cosmos, seeming to possess animate powers of the kind ascribed to planets. Consequently, he was harshly dismissive of the Aristotelian natural philosophy of the earth that he had pursued at Cambridge. Aristotelian philosophers, often called Peripatetics, divided the cosmos into a perfect superlunary realm, where stars moved themselves in circles, and, below the Moon, a corruptible terrestrial world composed of the four elements. Elemental earth was held to possess the passive qualities of coldness and dryness, and was therefore inactive. It descended naturally to the central point of the universe, furthest from the heavens; some Peripatetics even described the resulting stationary sphere as '*faeces mundi*'.

Freed from the university constraints to uphold Aristotelianism, Gilbert argued vehemently that, despite increased mining and global exploration, '[t]he Aristotelian element, earth, nowhere is seen, and the Peripatetics are misled by their vain dreams about the elements'. Indeed, 'Aristotle's "simplest element", and that most vain terrestrial phantasm of the Peripatetics – formless, inert, cold, dry, simple matter, the substratum of all things, having no activity – never appeared to any one even in dreams'.

Quite why Gilbert rejected traditional matter theory might have been recoverable from his lost papers. The cold winds that sweep across the North Sea to Cambridge may have provided one reason: Gilbert remarked that it was typically narrow-minded of the Greeks to have classified elemental air as hot and wet! In general, we are forced to reconstruct an account from the six books that comprise *De Magnete*, and from the tracts assembled posthumously by his half-brother into a manuscript called *De Mundo* and presented to Henry, Price of Wales. This work, of which Bacon possessed a copy, was not published until 1651. Translated, its title is *A New Philosophy of our Sublunary World*, with the subtitle *A New Natural Philosophy in Opposition to Aristotle*. These are good indications of Gilbert's general project, and provide a wider context in which to read *De Magnete*.

Gilbert's project was not unique. He can be grouped with contemporary 'nature philosophers', such as Francesco Patrizzi and Giordano

Bruno (both of whom he cited and criticised), who developed new cosmologies influenced by Neoplatonism. Gilbert shared with Bruno a conviction that an Earth with planet-like powers would also exhibit the planet-like motions given to it by Copernicus in 1543. Indeed, Gilbert was one of only ten writers to have advocated a fully heliocentric cosmology by 1600. But, unlike Bruno and the others, he had little expertise in Copernican astronomy, and we cannot be sure whether his Copernicanism was a cause or a consequence of his matter theory. Gilbert's uniqueness, in both natural philosophy and cosmology, stems from his conviction that he had empirical proof of a new, anti-Aristotelian theory of active terrestrial matter. That proof came from his discovery of the Earth's magnetism, laid out in *De Magnete*.

Gilbert's evidence and reasoning exemplifies his unprecedented experimentalism, which impressed supporter and opponent alike, and which ensured that *De Magnete* was not ignored. There is, however, no coherent *method* beyond two working principles.. The first is his sceptical empiricism: his insistence that, since nearly all established explanatory concepts were wrong, one had to reason from securely observed phenomena. The second is what we can call his central principle of analogy. Gilbert argued that a model of the Earth, a '*terrella*' turned from natural loadstone, replicated all the magnetic phenomena of the Earth itself, such as the orientation of compass needles. With this principle Gilbert explicitly denied, as did Bacon, the Aristotelian doctrine that 'art' (technology) could not imitate nature. Therefore, the Earth could be experimentally investigated in the laboratory.

Gilbert's most significant experiments were conducted with miniature compass needles – he called these *versoria*, or 'rotation detectors' – which he moved over the surface of *terrellae*. Books II–V describe how Gilbert replicated four of the five 'magnetic motions' that he identified: coition, or the attraction of opposite poles; direction, or north–south alignment; variation, conceived of as a slight rotation away from true north or south; and inclination, or magnetic dip. Gilbert therefore concluded, by analogy, that the Earth itself was a giant spherical loadstone – a claim flagged in the full title of *De Magnete*.

One experimentally grounded (though erroneous) analogy interested both natural philosophers and navigators, for whom it offered an explanation of magnetic variation. Variation, or the angle between a compass bearing and true north, was the bane of navigators. By 1600 its reality was undisputed, although its complex pattern of distribution had yielded numerous theories. Some regarded it as an instrumental artefact, but learned English navigators like Edward Wright preferred Simon Stevin's 1599 hypothesis. For Stevin, variation was no artefact; it was distributed irregularly in geographically specific patterns. Recognising these patterns through compass observations offered navigators a limited way of finding longitude at sea, or a *Havenfinding Art*, as Wright entitled his English translation of the Dutchman's work.

Gilbert had a loadstone 'crumbled away at a part of its surface and so having a depression comparable to the Atlantic sea'. According to Gilbert, *versoria* moving over this imperfect sphere exhibited similar patterns of variation to those recorded by transatlantic mariners. Variation was thus the consequence of the Earth's geological deviations from perfect sphericity. The explanation not only confirmed Stevin's haven-finding method; it also allowed Gilbert to argue that the Earth was essentially a perfectly spherical magnet, whose magnetic poles were identical with its geographical poles. Such inferences prepared Gilbert for the climactic Book VI, which cannot be dismissed as a lapse into 'fuzzy medieval speculation', as one historian put it, if only because much of *De Mundo* elaborates upon it.

In Book VI Gilbert marshalled evidence that magnetism was the motive force of the Earth's Copernican motions. He may have been inspired by the thirteenth-century writer Petrus Perigrinus, who claimed that a spherical magnet suspended from its pole rotated every twenty-four hours. Gilbert typically tested the claim and rejected it, at least for ordinary magnets. But for the 'prime magnet', i.e. the Earth, Gilbert asserted that its soul-like magnetic power did indeed imbue it with a fifth magnetic motion, that of rotation. Magnetism both rotated the Earth diurnally and magnetically stabilised its axis of rotation. Gilbert cleverly evaded any clear statement about the Earth's annual rotation, perhaps because he had no magnetic proof of it. In *De Mundo*, Gilbert went on to assert that each planet had its own specific power or virtue. The Earth's, and the Moon's, were magnetic; thus the Moon's orbit, and tides, were caused by magnetic attraction – an interesting adumbration of Newton's lunar theory. The sun had a luminous virtue, which 'predominated' and 'incited' the other planets to move around it. The virtues combined harmoniously to generate the planetary orbits. In this way Gilbert sketched out an experimentally grounded, natural philosophical dynamics for the Copernican system, the first to explain why a planet such as the Earth orbited the Sun, rotated stably on its axis in empty space, and exerted an attractive force on bodies in its vicinity.

His grand vision of a *philosophia magnetica* – a magnetic natural philosophy, not a science of magnets – accounts in large part for its appeal in the period prior to Newton's theory of gravitational attraction. As early as 1603, Johann Kepler wrote that he could 'demonstrate all the motions of the planets with these same [Gilbertian] principles'. He attempted to do so in his *Astronomia Nova* (1609), granting all the planets complex pairs of magnetic poles and calculating the resultant forces. Stevin promoted magnetic Copernicanism in the Dutch Republic. Galileo was another early Gilbertian, and the Inquisition criticised him for praising the 'perverse and quibbling heretic'. In 1657 Christopher Wren named Gilbert and Galileo as the two 'assertors of philosophical liberty'. Together with John Wilkins and Robert Hooke, Wren perpetuated Gilbert's model of attractive celestial forces into Newton's era.

With *De Magnete* popular among the seventeenth century's 'new philosophers', it is not surprising that Jesuit natural philosophers published more works on magnetism than did any other school of thought. Niccolo Cabeo paved the way in his *Philosophia Magnetica* of 1628, and brilliantly showed how Gilbert's discovery was, in fact, compatible with Aristotelian matter theory. Catholics troubled by the Galileo affair argued that the Creator had used magnetism as an additional cause of the Earth's immobility.

Since Gilbert's magnetic philosophy was closely tied to Copernicanism, it is superficially surprising that Gilbert did not attempt to discover any quantitative magnetic laws that could have advanced the emerging field of physical astronomy. In fact, just as Gilbert was the only non-astronomer amongst the early Copernicans, so was he unique in maintaining the conservative, scholastic distinction between mathematics and natural philosophy. Gilbert insisted that natural philosophers alone discovered physical causes, whilst mathematicians invented non-physical, fictional hypotheses to 'save the appearances' of the heavenly bodies. Gilbert was delighted that magnetic philosophy gave a real, physical, magnetic existence to the Earth's poles and parallels of latitude, entities that had previously been mere projections on to the Earth's surface of a revolving heavenly sphere. But, by the same token, Gilbert praised those astronomers who invented fictional orbits. Gilbert wrongly claimed that Copernicus and Tycho Brahe were fictionalists in this traditional sense. Indeed, Gilbert had an historical theory of cosmology, according to which error began in classical times when natural philosophers first misinterpreted mathematicians' orbits as real paths. Gilbert clearly shared Bacon's disregard of the power of mathematics to reform science.

Although Gilbert's position might seem backward looking, he had his reasons. They are evident in his concept of a magnet's 'sphere of virtue'. This *orbis virtutis* is only loosely related to later ideas of the magnetic field. Certainly Gilbert pointed to experimental proofs of magnetism's immateriality, for example that it passed through non-ferrous solids. Magnetism's immateriality was, for Gilbert, the important distinction between it and other traditionally occult attractions, such as electricity. (Gilbert's few electrical experiments were designed to show that 'electricity' was affected and, therefore, mediated by material effluvia, such as water vapour.) *De Magnete*'s diagrams are also reminiscent of modern 'lines of flux'. Gilbert was well aware that magnetic power decreased with distance and mobilised such demonstrable and law-like behaviour as further evidence that magnetism was no ordinary occult quality.

However, Gilbert ultimately denied that magnetic power could be analysed using mathematics, because mathematics was incapable of capturing its vitalist properties. Gilbert struggled for a language to describe the Earth's magnetism. The magnetic virtue in a loadstone was derivative of the whole Earth's more noble power. He shied away from a fully animistic model of this power, describing the Earth as 'as it were, ensouled' or as having a 'quasi-animate' power. Nevertheless, he considered that the Earth and other planets were able to respond to each other's powers. This resulted in a concerted heliocentric harmony that was irreducible to mathematical quantities. In modern terms, Gilbert held that the planets' mutual pertubations were too complex to analyse. It is an irony that the first plausible physicist of Copernican cosmology should have resisted Copernicus's own intention of uniting mathematics and physics. Gilbert's attitude was conventional, but there is another explanation. Edward Wright admitted to Mark Ridley, Gilbert's fellow physician, magnetician, and lodger, that Gilbert was 'not skilled in Copernicus' and needed instruction from one Joseph Jessop, another London physician and erstwhile fellow of King's. Gilbert seems to have concluded that mathematical difficulties represented mathematical impossibilities. The inability of Newtonian mechanics to solve the many body problems presented by planetary perturbations might be adduced in Gilbert's favour.

Gilbert's traditional subordination of mathematics to natural philosophy raises a problem in understanding *De Magnete*. One of the impressive, 'modern' features of *De Magnete* is its very use of mathematics, especially of practical techniques relating to navigation. Book VI concludes with two very technical chapters on Copernican models of the precession of the equinox. Book V contains instructions on how to make and use a magnetic inclinometer. There is also a complex, accurate geometrical nomograph that allowed sailors to read off their latitude from inclination measurements –another promising application of magnetic philosophy to navigation. Book IV, chapter XII contained state-of-the-art instructions for calculating variation from observations of bright stars. These practical elements, combined with

Gilbert's philosophising and Aristotle bashing, have influenced historians, especially Marxists, to read Gilbert as the first to effect a synthesis of practical or experimental expertise with philosophical rigour.

In fact, Edward Wright admitted to Ridley that he had written Book IV, chapter XII. I strongly suspect (as did Ridley) that Wright was also responsible for other technical sections. He certainly collaborated on the final stages of publication. Moreover, Wright's address to the reader presented *De Magnete* as primarily a contribution to magnetic navigation, and only secondarily as the creation of a magnetic philosophy.

This sheds interesting light on one of the great mysteries of Gilbert's work. Whilst *De Magnete* is thoroughly experimental, replete with geomagnetic data, bristling with new instruments, and full of practical applications, *De Mundo* is in a different genre. It is largely speculative Renaissance nature philosophy, resembling Patrizzi's discursive anti-Aristotelianism. It develops the speculative magnetic cosmology, and it adds, to the elemental theory of magnetic earth, a theory of aqueous and oily effluvia unsubstantiated by any experiment. Indeed, there are no new experiments in *De Mundo*; the empirical arguments draw on common-sense or anecdotal observations. It is tempting, therefore, to suggest that the rigorously experimental *De Magnete* is not the natural philosophical treatise Gilbert himself wanted to write, but a product of the collaboration with, and influence of, Wright.

The possibility that *De Magnete* arose out of the fusion of two Cambridge minds brings us back to Gilbert's debt to his Cambridge milieu. Obviously his Cambridge training in mathematics, natural philosophy, and medicine was crucial. At St John's, Gilbert acquired the professional medical skills that would propel him into the courtly and maritime communities of London. He also absorbed the traditional disciplinary boundaries of natural philosophy, the interconnection of matter theory and cosmology, and the (ir-)relevance of mathematics. Like all revolutionaries, Gilbert discarded much less traditional conceptual baggage than he thought. The opening chapters of

*De Magnete*, thorough, critical reviews of existing opinion, follow humanist dialectical method. The structure and chapter headings of *De Mundo*, such as '*De Aqua et Terra*', '*De motu gravium et levium*', '*De telluris loco*', and '*Meterorologia quid sit*', come straight from the scholastic curriculum, even if Gilbert denied that the entities existed or that the doctrines were right. It has been plausibly argued that his concept of *orbis virtutis* derives from the Aristotelian *sphaera activitatis*, and that his notion of the soul is Thomistic.

Moreover, Gilbert's scientific and medical careers both developed in the company of scholars who made up his Cambridge milieu. The community of mathematicians that flourished in Elizabethan Cambridge, and supplied London with lecturers in navigation, was literally instrumental in transforming magnetism into a topic for his experimental investigation.

Any innovative scientist, however, needs a disciplinary training and a community of intellectuals with whom to develop new ideas. In Gilbert's case we cannot point to any positive intellectual influence that he encountered through the university, as we can for Newton, who was influenced by the Cambridge Platonists, and for Harvey, whose anatomical discoveries depended upon the methodology he acquired at Padua from Fabricius. Gilbert certainly did not exclude Cambridge 'science' from his criticisms of Aristotelianism as dogmatic, stupid, stuck in the Renaissance cult of books and antique authorities, and shored up by long familiarity, proscriptions against free thought, and its incorporation into theology.

Of course, almost all Elizabethan natural philosophers were university educated, many at Cambridge. But in Gilbert's period the innovative action was in London, where noble patrons supported Paracelsian physican–philosophers like Thomas Moffett and Robert Fludd, or mathematicians like Digges and Wright. After 1596 London also had trusteeship of the foundation of the merchant Sir Thomas Gresham. Gresham College was designed to remedy Oxbridge's lack of relevance to the commercial world. Henry Briggs, another Johnian, moved to the metropolis, was appointed the first Gresham Professor of

Geometry, and collaborated with Gilbert and Wright in applying the discovery of the dip–latitude relation. The London milieu also shaped Francis Bacon's ideology, and introduced him to projects and examples of progressive technology that he compared favourably against conservative university philosophy.

Of course, the curriculum followed, and rejected, by Gilbert and Bacon had once been progressive and vocational; it was designed to produce men of letters to fill clerical, legal and other positions in an expanding state bureaucracy. Bacon acknowledged its continuing utility in some of these areas. But Gilbert and Bacon heralded a new era of *philosophia naturalis plus ultra*, that looked beyond the limits of classical contemplative knowledge to a new, applied science. Do not universities still have a tendency to defend as scholarship the vocational learning of a previous era?

## Further reading

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**William Gilbert** (1544–1603): English physician and natural philosopher: discoverer of terrestrial magnetism, pioneer of experimentalism and early developer of Copernicanism.

Gilbert studied medicine at St John's College, and rose to become a royal physician. His book *De Magnete* [On the Loadstone, 1600] is a classic of emerging experimental science and was closely studied throughout Europe. In it Gilbert investigated magnetic phenomena exhaustively, establishing magnetism's immaterial nature and distinguishing it from electricity. His major innovation was to use a spherical loadstone or '*terrella*' as a laboratory model of the Earth. He thereby demonstrated the Earth's magnetism, and developed numerous laws and insights to govern the use of compasses in navigation. Whilst these practical applications of magnetism ensured many followers, his biggest impact was in natural philosophy. Gilbert argued that the Earth's magnetic force was incompatible with Aristotelian science, and provided experimental proof of the Earth's motion. This 'magnetic philosophy' inspired Kepler, Galileo and Descartes, and provoked conservative responses from Jesuit scientists.

**Stephen Pumfrey** is Senior Lecturer in History of Science at the University of Lancaster. His 1987 doctoral dissertation was on William Gilbert and magnetic philosophy. He was a co-editor of and contributor to *Science, Culture and Popular Belief in Renaissance Europe* (Manchester, 1991), and has published numerous articles and chapters on the scientific revolution. He has close connections with Cambridge, having been born and educated there, including four years at Gilbert's College, St John's. His current research projects include a critical edition and translation of Gilbert's *De Mundo Nostro Sublunaria*, and a study of science and patronage in England, 1570–1626.