GILBERT, WILLIAM (1544-1603)

Born Colchester 1544; died London 1603. Gilbert's private papers have not survived, and comparatively little is known about his life. Son of a lawyer, he was educated at Colchester Grammar School and St John's College, Cambridge. He matriculated in 1558, gained an unexceptional B.A. and was elected a Fellow in 1561, proceeding M.A. in 1563. To become a Master he would have lectured on Aristotle's works, probably including *De Coelo* and *Meteorologica*. Subsequently he served as a college examiner in mathematics, which required only an elementary competence. He then joined the growing numbers studying medicine, receiving an M.D. from Cambridge in 1569; there is no evidence that he studied abroad like other ambitious physicians. From his Cambridge days survive the only books he is known to have owned: two volumes of Galen, one of Aristotle's natural philosophy, and Matthioli's commentary on Dioscorides. He moved to London, perhaps as early as 1571, to set up what became a flourishing medical practice. Although Gilbert directed his characteristic acerbity to many medical traditions, there is no evidence that his medical practice was unusually heterodox. By 1577 he was sufficiently established to obtain a grant of arms, and he entered the College of Physicians, being a Fellow and Censor (of standards of practice) in 1581. At this time his more general interest in natural philosophy expressed itself in meteorological observations.

In the 1580s he acquired powerful courtly patrons. Given the maritime and colonial emphasis of Elizabethan policy, he was especially valued for his expertise in naval and tropical physic. The naval connections doubtless stimulated his interest in the nautical compass and magnetism. In the 1590s Gilbert had become a leading physician, who had assisted with the College of Physicians' project for a pharmacopoeia, and who conversed at court with experts in navigation such as Francis Drake, Thomas Cavendish and William Barlow. His St Paul's residence, Wingfield House, became a centre of intellectual discussion according to one lodger, the diarist John Chamberlain, who also noted that Gilbert disliked religious zeal. By now, if not in the 1580s as he implied, he was privately experimenting and writing about magnetism and developing an anti-Aristotelian natural philosophy. From 1599 he collaborated closely, especially concerning technical aspects of magnetic navigation, with the leading London practitioner Edward Wright. He published some of this work as his *De Magnete* after his reputation was secured, earlier in 1600, by his election to the Presidency of the College of Physicians and his appointment as one of Elizabeth I's physicians. James I renewed his appointment in 1603.

He did not live long enough to witness the international fame of *De Magnete*, although in his only surviving letter, of 1602, he told Barlow of an encomiastic letter from Galileo's Venetian collaborator, Fra Paolo Sarpi. He helped to develop navigational applications of his magnetic theory in collaboration with Wright, Thomas Blundeville and Henry Briggs. He did not, however, complete and publish his manuscripts of more general natural philosophy before he died, probably from plague, in December 1603. A wealthy man, he bequeathed his books and apparatus to the College of Physicians, but the College, like Wingfield House, was destroyed by the fire of 1666. Some literary remains

were collected by his half brother William and donated to the King's Library as a manuscript work *De Mundo nostro Sublunari Philosophia Nova*. Sir Francis Bacon had a copy, and an edition was eventually published in 1651.

Gilbert has been in the pantheon of the history of science since the late 18th century. Until recently, his significant achievements were considered to be his pioneering use of experimental method; his discovery, empirical proof and theory of terrestrial magnetism; and his discrimination of electric from magnetic phenomena. (Although he coined the word *electricitas* he is mistakenly dubbed 'the father of electricity'.) A less Whiggish or present-centred evaluation, which takes into account the context of seventeenth-century philosophy, requires some revision. We are forced to rely upon the internal evidence of the two works and contemporary responses to *De Magnete*, which treated it as magnetic philosophy, not science.

Gilbert's most central philosophical position was his belief that the Earth was a noble part of the cosmos that seemed to possess animate powers of the kind usually reserved for planets. He therefore deplored the Aristotelian natural philosophy that dominated late-sixteenth and early seventeenth-century intellectual culture, especially at Cambridge University. Aristotelianism divided the cosmos into a perfect superlunary realm, where stars moved in perfect circles, and, below the Moon, a corruptible terrestrial region of the four elements. Elemental earth was held to be cold, dry and possessing the property of gravity, by which it sought the central point of the universe, furthest from the heavens; some even described the resulting stationary ball as '*faeces mundi*'.

Gilbert was not alone in rejecting the doctrine; so had earlier Renaissance 'nature philosophers' like the Italians Bernardino Telesio, Francesco Patrizzi and Giordano Bruno, all of whom Gilbert cited. In *De Mundo* he adopted the same genre as Telesio and Patrizzi, essaying a new cosmology that begins with a critical rejection of Aristotelian element theory and works speculatively up to the heavens. Gilbert's uniqueness, and more enduring reputation, stems from his conviction that he had empirical proof of a new, anti-Aristotelian theory of matter. That proof came from his discovery of the Earth's magnetism.

Gilbert's evidence and reasoning, which occupy most of the six books of *De Magnete*, exemplify an unprecedented experimentalism. However, whilst *De Magnete* is the first experimental treatise in the history of science, it does not expound a coherent experimental method. The proof uses a principle of analogy; Gilbert argued that a laboratory model of the earth, or *terrella*, turned from natural loadstone, replicated all magnetic phenomena on the surface of the Earth reported by sailors and other investigators. With this argument Gilbert explicitly denied (as did Bacon) the Aristotelian doctrine that 'art' (technology) cannot imitate nature, and so provided a justification for experimentalism. Using a miniature compass needle, or *versorium*, moved over the *terrella*, Gilbert produced in books II-V four of the 'magnetic motions' visible on the Earth: coition, or the attraction of opposite poles; direction, or north-south alignment; variation away from true north; and dip, or inclination. In one persuasively impressive but flawed series of experiments, Gilbert 'replicated' the oceanic patterns of

magnetic variation that so baffled navigators by introducing into a loadstone 'a depression comparable to the Atlantic sea'.

Gilbert's theoretical conclusion, that the earth was a giant spherical loadstone with just sufficient surface irregularities to explain variation, gave navigational science its first successful explanation of the compass, and Books III to V received much practical attention in the 17th century. Furthermore Book II created an investigative paradigm for magnetic attraction and repulsion (terms which Gilbert rejected as applying to 'violent motion'). But we are justified in regarding the doctrines of the controversial Book VI as Gilbert's crowning climax, not least because of their dominant place in *De Mundo*.

Book VI mentioned the report of the medieval natural philosopher Petrus Peregrinus (an important source for Gilbert) that a suspended spherical magnet rotated every twenty-four hours, in imitation of the heavens. Gilbert typically tested and rejected it, and argued that such diurnal rotation would be the property only of the prime magnet, the Earth itself. For him, the Earth's soul-like magnetic power gave it both the capacity for (daily) rotation and a magnetically stabilised axis about which to rotate. He was, therefore, at least a semi-Copernican and, although he cleverly evaded any clear statement about an annual rotation of the Earth around the Sun, was almost certainly a full Copernican. *De Magnete* concludes with almost direct quotations of Copernicus' own arguments. In *De Mundo* Gilbert further asserted that each planet has its specific power or virtue, with the Earth's (and the Moon's) being magnetic, and the Sun's luminous virtue being predominant and 'inciting'. Combining in non-violent harmony, these celestial powers generated the planetary orbits.

One might mention at this point Gilbert's concept of the magnet's 'sphere of activity'. For Gilbert, magnetism was immaterial (and hence soul-like), something which he held to distinguish it from other 'occult' attractions such as electricity, which were mediated by subtle effluvia. The sphere of magnetic activity had to be made visible and mapped, by observing a *versorium* at various positions and distances from a loadstone. Although diagrams in *De Magnete* are reminiscent of modern 'lines of flux', and although Gilbert knew that magnetic power decreased with distance, it is anachronistic to see him as anticipating field theory. Quite apart from Gilbert's animate ontology, he also denied that the magnetic and other cosmic forces could usefully be analysed mathematically. (It is true, however, that Gilbert saw the lawlikeness of magnetism as proof of its reality, unlike almost all other occult qualities. This did not prevent some seventeenth-century occult philosophers, such as Robert Fludd and Athanasius Kircher, from recasting natural magic in terms of magnetic philosophy. Their doomed attempts to appropriate *De Magnete*'s authority produced some of the earliest debates about the significance of Gilbert's doctrines.)

Given Gilbert's Copernicanism, he maintained a surprisingly conservative (indeed Aristotelian) metaphysical distinction between mathematics and natural philosophy. According to this, natural philosophers alone discovered physical causes, whilst mathematicians invented non-physical, fictional hypotheses to 'save the appearances'. Gilbert was pleased to have replaced the geographers' conventional poles, parallels of

latitude and meridians of longitude, which were merely projections of the heavenly sphere onto the earth, with a real, magnetic topography. In astronomy, however, Gilbert praised mathematicians (including Copernicus and Tycho Brahe) for their invention of fictional orbits. This was necessary, he argued, because the perturbating interactions of the planetary virtues defied calculation. Gilbert therefore contrasts with the handful of other known Copernicans in 1600, notably the mathematicians Galileo, Johann Kepler and Simon Stevin, who pioneered the new discipline of physical astronomy. According to Wright, Gilbert was not 'skilled in Copernicus'.

Herein lies an explanation of the philosophical impact of *De Magnete*. Alone in 1600, and uniquely before Isaac Newton's 1687 work on gravitation, Gilbert's theory of magnetism offered a plausible, natural philosophical dynamics with which to establish Copernican astronomy. As heliocentrism gained adherents and worried conservative theologians, leading to the trial of Galileo of 1633, Gilbert's work received close attention. It is in this context that we should interpret Gilbert's boast that he had established a 'new, magnetic philosophy'. Contemporaries rightly did not take him to denote merely an empirical science of magnets, but a whole natural philosophy which, by ascribing a motive power to elemental earth, and to the Earth itself, struck at the core of Aristotelian matter theory and geostatic cosmology.

Stevin and Kepler were early proponents of magnetic philosophy. In 1603 Kepler wrote that he could 'demonstrate all the motions of the planets with these same [Gilbertian] principles', a task he attempted in his *Astronomia Nova* (1605). The extraordinary accuracy of Kepler's 'magnetic astronomy' combined with Galileo's endorsement of Gilbert, a 'perverse and quibbling heretic' according to one examiner in his trial of 1633, to increase interest. Christopher Wren named Gilbert and Galileo as the 'assertors of philosophical liberty'. To counter the threat, natural philosophers of the Society of Jesus promoted an orthodox interpretation of Gilbert's work in a series of lavish, and sometimes brilliant treatises. In his *Philosophia Magnetica* of 1628, Niccolo Cabeo succeeded in showing that magnetism could be incorporated as a hitherto undiscovered Aristotelian quality which, being Aristotelian, acted to ensure the Earth's immobility. These Jesuit defences were partly responsible for the abandonment, after 1650, of Gilbert's central principle of inference by analogy from *terrellae* to the Earth. Furthermore, by 1660 the currency among 'new philosophers' of quasi-Cartesian mechanistic theories of matter made Gilbert's immaterialist ontology unacceptable. But lingering interest, especially in England, in magnetism as evidence of supra-mechanical forces was one stimulus to Newton's theory of gravitational attraction.

Gilbert's reputation was not increased by the publication of *De Mundo* in 1651. Natural philosophy had undergone revolutionary advance. Also responsible was the contrast with *De Magnete*, whose thorough empiricism was strangely lacking. Instead there is speculative Renaissance nature philosophy. It adds an unsubstantiated theory of aqueous and oily effluvia to the elemental theory of magnetic earth, it develops the cosmological notions of Book VI, and it concludes with increasingly disordered reflections structured around Aristotle's *Meteorologica*.

Whilst *De Mundo* is of uncertain provenance, its unremarkable method raises further questions about how thoroughly experimental was Gilbert's philosophy. Certainly Gilbert shared, indeed pre-empted, many of Bacon's doctrines. He agreed that Renaissance philosophy, especially the Aristotelianism they encountered at Cambridge, was enslaved to classical authorities and logical exposition. He agreed that experienced craftsmen knew more about nature, and that natural philosophy should be utilitarian. Again like Bacon, his demand for a reformed philosophy was predicated upon a scepticism about *prisca sapientia* [an ancient wisdom], a crude historical sociology of philosophy's erroneous development (particularly owing to theological constraints), and a novel belief in progress. Yet Bacon's barb that Gilbert had 'made a philosophy out of the loadstone' is apt.

We know that Edward Wright contributed to *De Magnete* not only data, practical expertise and a preface emphasising its relevance to navigational science; he also wrote several technical chapters. If we suppose *De Magnete* to be a collaboration in which Gilbert's natural philosophy was tempered by Wright's empiricism, then we add a new twist to Edgar Zilsel's hypothesis; that Gilbert's pioneering 'experimental method' was fostered by a new synthesis of head- and hand-knowledge in commercial milieux like seventeenth-century London.

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Further Reading

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