

An electromagnetic personality

An Elizabethan experimentalist and spirited foe of pseudoscience.

James D. Livingston

Amidst all the millennial media hoopla, one significant anniversary has passed unnoticed. This year is the quadricentennial of the publication of William Gilbert's masterpiece, *De Magnete*. Galileo praised it lavishly, Kepler cited it as an influence on his work on planetary motion, and to the science historian George Sarton it was "one of the greatest books of Science".

William Gilbert was born in Colchester in 1544 and educated at Cambridge. He practised medicine in London, and held various positions in the Royal College of Physicians, including president. In 1600, Gilbert was appointed one of Queen Elizabeth's personal physicians. On her death in 1603, he became physician to her successor, James I, but Gilbert outlived Elizabeth by only a few months. Although his brother later published some of his other writings, Gilbert's fame as the founder of magnetic and electrical science rests entirely on *De Magnete*. Dryden memorialized him with this couplet, of which at least one of the conditions still ensures his immortality: "Gilbert shall live till lodestones cease to draw/ Or British fleets the boundless ocean awe."

Gilbert argued that "stronger reasons are obtained from sure experiments and demonstrated arguments than from probable conjectures and the opinions of philosophical speculators". He then proceeded to examine, by careful experiment, a wide variety of common beliefs about magnets and magnetic forces. Previous authors had claimed that magnets lose their attractive power when rubbed with garlic, or in the presence of diamonds. He showed otherwise, and ridiculed many other legends, including claims that a lodestone placed under the head of a sleeping woman would drive her out of bed if she were an adulteress — although in this case, his experiments went undescribed.

Earlier authors had lumped together the mysterious powers of lodestones and amber. But Gilbert's experiments showed the differences between magnetic forces, which were limited to lodestones and iron, and electrostatic forces, which could be produced by, and act on, many different materials. These tests were the first to demonstrate electrostatic forces using an electroscope, and in describing his results he coined the term 'electric', based on the Greek word for amber. There was little progress in the science of electricity and magnetism beyond *De Magnete* for nearly two centuries, until Coulomb's more quantitative measurements.

Among Gilbert's most important experiments were those studying the orientation of iron needles close to a spherical lodestone. Recognizing the link to mariners' observations of the dip of compass needles, he concluded "*magnus magnes ipse est globus terrestris*" (the Earth's globe itself is a great magnet) — a remarkably wide-ranging conclusion reached from simple table-top experiments.

Ocean navigation was of great importance in Elizabethan England, and Gilbert described the variation of compass direction and dip around the globe in great detail, with the ultimately unsuccessful goal of using compass readings to determine both latitude and longitude. As his experiments had shown that opposite magnetic poles attract, the south pole of the compass needle obviously pointed north, and anyone who defined magnetic poles differently was in error, "so ill-cultivated is the whole philosophy of the magnet still, even as regards its elementary principles". Gilbert's logic was impeccable, but failed to convince compass users to reverse their labelling. Thus by standard scientific

terminology, the Earth's south magnetic pole is in the Arctic, and its north magnetic pole in the Antarctic, but don't blame Gilbert.

Much of *De Magnete* is a ground-breaking demonstration of experimental physics, but in the final sections Gilbert extended his thinking into theories of astronomy and cosmology. These metaphysical excursions drew strong criticism from Francis Bacon, whose name we associate with the scientific method. But in Sarton's judgement, Bacon himself "would have been unable to apply his own method as brilliantly as Gilbert did".

An inexpensive paperback edition of *De Magnete* is available in English translation, and parts of it are still very lively reading, particularly where Gilbert fumes about writers who promulgate untested legends as fact. About reports of magnet-based perpetual-motion engines: "May the gods damn all such sham, pilfered, distorted works, which do but muddle the minds of students!" About broad medical claims for magnets: "Thus do pretenders to science vainly and preposterously seek for remedies, ignorant of the true causes of things." Four centuries on, perpetual-motion machines based on magnets are still promoted, and 'therapeutic' magnets are sold by the millions to a gullible public. Gilbert would still be angry, but I don't think he would be surprised. ■

James D. Livingston is in the Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 12309, USA.

He ridiculed claims that a lodestone would drive a sleeping adulteress out of bed.



A. Ackland Hunt's (probably imaginary) painting of Gilbert showing his experiments to Elizabeth I.

COLCHESTER MUSEUMS