Northwestern University Feinberg School of Medicine

Galter Health Sciences Library & Learning Center

From the Library's Vault: Foundations and Seminal Works of Scientific Method, 1504-1793

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The current exhibit in the Eckenhoff Reference Room on Level 1 of the Galter Health Sciences Library highlights works in science from the 16th to the 18th centuries.

John Peckham's *Perspectiva communis* (1504), translated as 'Common perspectives,' was originally composed between 1277 and 1279, with the first printed edition published in 1482. It was considered the standard university text in optics and vision during that time period, used and cited by many medieval and Renaissance natural philosophers, including Lorenzo Ghiberti, Leonardo da Vinci, and Johannes Kepler. The Library's edition contains remarkable woodcut illustrations, including a diagram of the eye, considered by some to be the earliest to appear in a printed book.

William Gilbert's text *De Magnete* (1600), translated as 'On the magnet,' is the first major English scientific treatise based on experimental methods of research, and the foundation work of magnetism and electrical science. He introduced the terms 'electricity,' 'electric force,' and 'electric attraction,' and established the theorem that the earth was a gigantic spherical magnet, a proposition that fostered subsequent works on terrestrial magnetic variations, magnetic storms and charting of the earth's magnetic fields by Halley, Gauss, and Sabine.

The heliocentric hypothesis of Copernicus gained momentum when **Galileo Galilei** published his *Dialogo* in 1632. Galileo thought he had proof of the theory when he viewed four satellites of Jupiter through his telescope and saw that they appeared in different positions relative to the planet. He was convinced that they were circling Jupiter just as the earth was revolving around the sun.

The Roman Catholic Church was not convinced.

In a small posthumously published volume, **Blaise Pascal** correlated hydrostatics and aerostatics by simple demonstrable relationships and banished the myth that 'nature abhors a vacuum.' His text, *Traitez de l'equilibre des liqueurs, et de la pesanteur de la masse de l'air* (1663) are unquestionably a classic of seventeenth-century science for their treatment of the subject with clarity and thoroughness.

Robert Boyle's *Sceptical chymist: or Chymico-physical doubts & paradoxes,* published in 1661, is a masterpiece of scientific literature. In the form of a dialogue, the text presented Boyle's hypothesis that matter consisted of atoms and clusters of atoms in motion and that every phenomenon was the result of collisions of particles in motion. He appealed to chemists to experiment and asserted that experiments denied the limiting of chemical elements to only the classic four: earth, fire, air, and water. He also pleaded that chemistry should cease to be subservient to medicine or to alchemy, and rise to the status of a science. Importantly, he advocated a rigorous approach to scientific experiment: he believed all theories must be proved experimentally before being regarded as true.

The Library's copy is a rare Latin edition published in 1662.

Evangelista Torricelli was a pupil of Galileo and succeeded him as professor of mathematics at Florence. His *Lezioni Accademiche* (1715) contains twelve posthumously published academic lectures.

One of the lectures from 1643 demonstrated that atmospheric pressure determines the height to which a fluid will rise in a tube inverted over the same liquid. Torricelli also noted variations in the column's height with changes in time and weather.

Cosmotheoros: or, conjectures concerning the inhabitants of the planets by **Christiaan Huygens** was published in Latin in 1689 and the first English translation was published the same year. The Library's copy is a third English language edition (1757).

Huygens' text contains one of the earliest discussions of the possibility of alien life and the plurality of worlds. He argued that in the Copernican world system, the earth holds no privileged position among the other planets, therefore it would be reasonable to suppose that life should not be restricted to earth alone.

Extraterrestrial life was a subject of speculation, but the discoveries made possible by the telescope spurred a new fascination with what has been called the modern scientific moon voyage.

Isaac Newton is represented by his *Opticks* (1721), a comprehensive survey of 18th-century knowledge of light, describing Newton's own experiments with spectroscopy, colors, lenses, reflection, refraction and more in language that the lay person can easily follow.

Previous philosophers and mathematicians had been sure that white light was pure and simple, regarding colors as modifications of qualifications of the white. Newton showed experimentally that the opposite is true.

The great achievement of the work was to show that color was a mathematically definable property.

Newton's *Mathematical Principles of Natural Philosophy* (1729) is the first English language edition of his *Principia* (1687) and is generally described as the greatest work in the history of science. Copernicus, Galileo and Kepler had certainly shown the way, but where they described the phenomena they observed, Newton explained the underlying universal laws. The *Principia* provided the greatest synthesis of the cosmos, proving finally its physical unity. Newton showed that the important and dramatic aspects of nature that were subject to the universal law of gravitation could be explained in mathematical terms with a single physical theory. With this, the separation of the natural and supernatural, of sub lunar and super lunar worlds disappeared. The same laws of gravitation and motion rule everywhere; for the first time a single mathematical law could explain the motion of objects on earth as well as the phenomena of the heavens. The whole cosmos is composed of inter-connecting parts influencing each other according to these laws. It was this grand conception that produced a general revolution in human thought, equaled perhaps only by that following Darwin's *Origin of Species* (1859). Newton is generally regarded as one of the greatest mathematicians of all time and the founder of mathematical physics.

Herman Boerhaave is considered the founder of clinical teaching, the modern academic hospital, organic chemistry, and the chemistry of carbon compounds.

His two volume publication *Elementa Chemiae* (1732) is the first authorized edition, signed by Herman Boerhaave on the verso of the title page.

Joseph Priestley's *Experiments and observations on different kinds of air...* (1775-1777; 3 volumes) led to the identification of numerous gases, including ammonia, nitrogen dioxide, and oxygen, which he obtained by heating mercuric oxide. Priestley has long been credited with the discovery of oxygen, as he was the first to publish his discovery. Priestley's experiments with gases led Cavendish and Watt to discover the compound nature of water, and it was this revelation, coupled with Priestley's isolation of oxygen, that formed the experimental basis of Lavoisier's oxidation chemistry.

Benjamin Franklin's *Experiments and observations on electricity … to which are added, letters and papers on philosophical subjects* (1769) may give the impression that the book is solely an exploration of Franklin's work with electricity. In fact, the book covers an assortment of topics including mathematics, natural phenomena (such as theories on the source of aurora borealis, hurricanes, and shooting stars), economics, population growth, and the 1752 outbreak of smallpox in Boston.

Dr. Franklin edited this edition personally, publishing some of his most famous discoveries and inventions, for example, the Franklin stove and his experiment with the key and kite.

Barthélemy Faujas de Saint-Fond was an early supporter of *aerostation* and was its first chronicler. In November 1783, he published the first serious treatise on *aerostation*, documenting the experiments of the Montgolfier Brothers in his

Description des expériences de la machine aérostatique (1784).

He gives particulars as to how the different balloons were constructed as well as tables showing various scientific observations that were made about the balloons and how they compare with what scientific theory said should happen.

Antoine Lavoisier's *Traite elementaire de chimie* (2^{nd} ed., 1793; 2 volumes) is considered the first modern chemistry textbook. Lavoisier presented a unified view of new theories of chemistry, providing a clear statement of the law of conservation of mass and denial of the existence of phlogiston. In addition, he clarified the concept of an element as a simple substance that cannot be broken down by any known method of chemical analysis, and developed a theory of the formation of chemical compounds from elements.
