



Martin Luther in the Circle of Reformers, 1625–50 (oil on panel), by an artist of the German School.

## HISTORY

# Science and the Reformation

The scientific and religious revolutions that began 500 years ago were not causally related, but were both stimulated by printing, argues **David Wootton**.

On 31 October 1517, as legend has it, renegade monk Martin Luther nailed a document to the door of All Saints' Church in Wittenberg, Germany. The *Ninety-five Theses* marked the beginning of the Reformation, the first major break in the unity of Christianity since 1054. Luther proclaimed a radical new theology: salvation by faith alone, the priesthood of all believers, the ultimate authority not of the Church, but of the Bible. By 1520, he had rejected the authority of the pope. Lutherans and followers of French reformer John Calvin found themselves engaged in bitter wars against Catholicism that lasted for a century and a half.

This age of religious warfare was also the age of the scientific revolution: Nicolaus Copernicus's *On the Revolutions of the Celestial Spheres* (1543), Tycho Brahe's *Introduction to the New Astronomy* (1588), Johannes Kepler's *New Astronomy* (1609),

Galileo Galilei's telescopic discoveries (1610), the experiments with air pressure and the vacuum by Blaise Pascal (1648) and Robert Boyle (1660), and Isaac Newton's *Principia* (1687).

Were the Reformation and this revolution merely coincident, or did the Reformation somehow facilitate or foster the new science, which rejected traditional authorities such as Aristotle and relied on experiments and empirical information? Suppose Martin Luther had never existed; suppose the Reformation had never taken place. Would the history of science have been fundamentally different? Would there have been no scientific revolution? Would we still be living in the world of the horse and cart, the quill pen and the matchlock firearm? Can we imagine a Catholic Newton, or is Newton's Protestantism somehow fundamental to his science?

The key book on this subject was published in 1938 by Robert Merton, the great US

sociologist who went on to invent terms that have become part of everyday speech, such as 'role model', 'unanticipated consequence' and 'self-fulfilling prophecy'. Merton's first book, *Science, Technology and Society in Seventeenth-Century England*, attracted little attention initially. But in the 1960s, 1970s and 1980s, historians of science endlessly and inconclusively debated what they called the Merton thesis: that Puritanism, the religion of the founders of the New England colonies, had fostered scientific enquiry, and that this was precisely why England, where the religion had motivated a civil war, had a central role in the construction of modern science.

Those debates have fallen quiet. But it is still widely argued by historians of science that the Protestant religion and the new science were inextricably intertwined, as Protestantism turned away from the spirituality of Catholicism and fostered a practical engagement with the world, exemplified in the idea that a person's occupation was their vocation. Merton was following in the footsteps of German sociologist Max Weber, who argued that Protestantism had led to capitalism.

I disagree. First, plenty of great sixteenth- and seventeenth-century scientists were Catholics, including Copernicus, Galileo and Pascal. Second, one of the most striking features of the new science was how easily it passed back and forth between Catholics and Protestants. At the height of the religious wars, two Protestant astronomers were appointed one after another as mathematicians to the Catholic Holy Roman Emperor: first Brahe, then Kepler. Louis XIV, who expelled the Protestants from France in 1685, had previously hired Protestants such as Christiaan Huygens for his Academy of Sciences. The experiments of Pascal, a devout Catholic, were quickly copied in England by the devoutly Protestant Boyle. The Catholic Church banned Copernicanism, but was quick to change its mind in the light of Newton's discoveries. And third, if we can point to Protestant communities that seem to have produced more than their share of great scientists, we can also point to Protestant societies where the new science did not flourish until later — Scotland, for example.

## DISCOVERY AND DISSEMINATION

What made the scientific revolution possible were three developments. A new confidence in the possibility of discovery was the first: there was no word for discovery in European languages before exploration uncovered the Americas. The printing press was the second. It brought about an information revolution: instead of commenting on a few canonical texts, intellectuals learnt to navigate whole libraries of information. In the process, they invented the modern idea of the fact — reliable information that could be checked and tested. Finally, there was the

new claim by mathematicians to be better at understanding the world than philosophers, a claim that was grounded in their development of the experimental method.

If the scientific revolution is properly called a revolution, it is because of that: the mathematicians seized power and prestige from the philosophers. The challenge is in the full title of Newton's *Principia: Philosophiæ Naturalis Principia Mathematica* — the mathematical principles of natural philosophy. This revolt goes back to works such as Niccolò Fontana Tartaglia's *New Science* of 1537, a study in the mathematics of artillery. The frontispiece shows ancient Greek mathematician Euclid holding the gate through which one must pass to attain true knowledge, announcing the new ambition of mathematicians to interpret the world. With the exceptions of Boyle and anatomist Andreas Vesalius, all the scientists I mention here were mathematicians, and even Boyle is remembered for a law on the behaviour of gases that he discovered with the help of mathematicians.

### BREAK WITH TRADITION

This was no easy or rapid victory: philosophy, particularly Aristotelianism, had long had a powerful hold over Europe's intellectual life. It was widely held that Aristotle had known everything worth knowing about nature, and that to recover that knowledge one had only to study his texts with exquisite care, rather than explore what Galileo and others called the book of nature. The key question is: did the Protestant Reformation encourage the turn from the books of Aristotle to the book of nature?

Certainly, Aristotelian philosophy was embedded in Catholic theology. The Catholic doctrine of transubstantiation — that in the Mass, bread and wine become the body and blood of Christ — was propounded through Aristotelian ideas about essence and appearance. The Catholic Church condemned the writings of René Descartes because his emphasis on the quantifiable was seen as incompatible with this doctrine. The mechanical philosophy of Descartes and others became the intellectual underpinning of much of the new science in the second half of the seventeenth century, but was always suspect in Catholic countries.

However, in the real world, things were not so simple. The first powerful advocate of the mechanical philosophy was a Catholic priest (and professor of mathematics), Pierre Gassendi; Descartes never wavered in his Catholicism, although he did choose to live in the Protestant Netherlands. Both Catholic and Protestant theologians knew that Aristotle had denied the immortality of the soul and the creation of the Universe, and were

accustomed to making a sharp intellectual distinction between his philosophy and Christian theology. Even in the Netherlands, the Cartesians were able to establish themselves in universities only by insisting that they, too, were entitled to keep their philosophy distinct from their theology.

### NOT SO DIFFERENT

Protestants did not reject Aristotelianism. Their universities outside the Netherlands were as wedded to it as Catholic ones. In England, a chair in natural philosophy was established in 1621 at Oxford, one of the universities most open to the new science. Yet until the end of the century, its holders were required to teach Aristotle; Oxford's mathematicians taught the new physics and astronomy of Galileo, Kepler and Newton.

Moreover, Catholics were often just as willing as Protestants to make intellectual space for the new science. Kepler's argument that Copernicanism could be reconciled with the Bible was censored by Protestant theologians, but later published under Catholic Holy Roman Emperor Rudolph II. And among both Catholics and Protestants, religious commitment sometimes clashed with scientific activity. Pascal gave up science after a religious experience; so did the Protestant Jan Swammerdam, one of the first great microscopists. And although Protestants had a tradition of disputing authority and undertaking radical change, Protestantism as a state religion could be as conservative as Catholicism. If England led the way in promoting the new science, the relative openness and intellectual diversity of its culture after the restoration of the monarchy in 1660 is more significant than the religion of its scientists.

What fatally weakened the hold of the old Aristotelian physics and Ptolemaic astronomy was the voyages of discovery, followed by the invention of the telescope and the barometer. It was not the Reformation: the scientific revolution would have taken place without that. Indeed, progress might even have

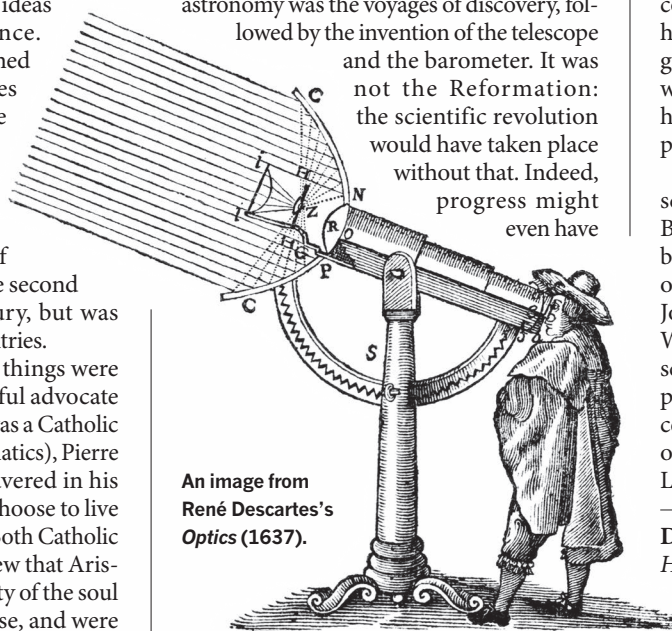
been more rapid, because the Church would have been less dogmatic in responding to novelty. The Council of Trent (1545–63), assembled by the Catholic Church in reaction to Luther's bombshell, tightened up doctrine, requiring it to conform to long-established tradition. This led directly to the condemnation of Copernicanism and its heliocentric cosmos as heretical. One only has to think of the continuing clash between Protestant fundamentalism and Darwinism to see that there is no straightforward match between Protestantism and scientific values. The Catholic Church has never condemned Darwinism.

So, let's for a moment imagine again that there had been no *Ninety-Five Theses*, no Reformation, no Protestantism. In this alternative world, Copernicus would surely have published *On the Revolutions*, and Vesalius his 1543 treatise *On the Fabric of the Human Body*. Brahe would have observed the supernova of 1572 and the comet of 1577; the telescope would still have been invented; and Galileo would have observed the phases of Venus and discovered the law of free fall. The intellectual problems that led to Kepler's new astronomy, and made possible the Newtonian synthesis, would still have been in place by the early seventeenth century.

Scientists, as scientists, are under no particular obligation to either celebrate or bemoan the publication of Luther's theses 500 years ago. There have been great Protestant and Catholic scientists, and others who had different faiths or (perhaps including Galileo) no religious belief at all. What happened in the scientific revolution was that science developed its own procedures and modes of enquiry and thus established its independence from both philosophers and theologians. Newton's heresy (he was a Unitarian) and his obsession with biblical chronology as a tool for calculating the coming end of the world neither helped nor hindered him in formulating his theory of gravity, any more than Pascal's heresy (he was a Jansensist, a denier of free will) helped him to develop a sophisticated theory of pressure in liquids and gases.

The link between the Reformation and the scientific revolution is not one of causation. But it is more than a coincidence, because both were made possible by the rapid growth of printing in the years after 1439, when Johannes Gutenberg developed his press. Where previous reform movements, in both science and religion, had failed dismally, the press made it possible for these two to succeed. If we are looking for the preconditions of modern science, it's to Gutenberg, not Luther, that we should turn. ■

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An image from René Descartes's *Optics* (1637).