

THE NEW SCIENCE

The “scientific revolution” is usually associated with the sixteenth and seventeenth centuries, although, of course, its origins may be traced back further still. But for a technique or an idea to be historically significant, mere existence is not enough: acceptance and practice are needed, and success is, to some extent, measured quantitatively. This is why the seventeenth century seems crucial to that revolution which, in the words of Herbert Butterfield (*The Origins of Modern Science*, London, 1949), “overturned the authority in science not only of the middle ages but of the ancient world.” To Professor Butterfield this change of techniques and attitudes is the most important event since the rise of Christianity, more important by far than the Renaissance or the Reformation: “Since it changed the character of men’s habitual mental operations even in the conduct of the non-material sciences, while transforming the whole diagram of the physical universe and the very texture of human life itself, it looms so large as the real origin both of the modern world and of the modern mentality that our customary periodisation of European history has become an anachronism and an encumbrance.”

Quite apart from the new interpretations and perspectives these words suggest, it is interesting to see that such tremendous changes came about in the first place and quite literally as changes of mind; in other words, not as a result of new discoveries, new facts, new observations, but of new ways of looking at evidence that had been available for quite some time. What we find in the work of Descartes or Newton, as in that of William Harvey or Galileo, is “the art of handling the same bundle of data as before, but placing them in a new system of relations with one another by giving them a new framework.” It was a system that would prepare people’s minds for Darwin’s *Origin of Species* two centuries later.

Galileo: What Is Scientific Authority?

In the early sixteenth century, Nicolaus Copernicus (1473–1543) proposed the theory that, contrary to accepted views of a stable earth around which sun and other planets revolve, the earth was one of several planets that turn around a stationary sun. A hundred years after Copernicus, an Italian mathematician, astronomer, and physicist named Galileo Galilei (1564–1642), heard about a new invention—the telescope—that could be used to observe what went on in the skies. After building his own telescope, Galileo found that the surface of the moon was irregular, not smooth; discovered the satellites of Jupiter and the rings of Saturn; observed spots on the sun; and became convinced Copernicus was right. The implications of Galileo’s discoveries, which challenged accepted philosophy and

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beliefs, were soon denounced as blasphemous. To defend himself, Galileo wrote a number of public letters. Excerpts from one of these, written in 1615 and addressed to the grand duchess of Tuscany, wife of his patron, follow. Neither Galileo’s arguments nor his scientific data prevented Copernicanism from being declared “false and erroneous” or Copernicus’s works from being placed on the Index of prohibited books. Galileo, who continued to discuss the world system as he saw it, was eventually brought to trial on suspicion of heresy in 1633 and was forced to recant his views. He spent the last years of his life under house arrest on his estate near Florence, busily corresponding with scientists all over Europe and developing views that even condemnation could not prevent from being right.

Some years ago, as Your Serene Highness well knows, I discovered in the heavens many things that had not been seen before our own age. The novelty of these things, as well as some consequences which followed from them in contradiction to the physical notions commonly held among academic philosophers, stirred up against me no small number of professors—as if I had placed these things in the sky with my own hands in order to upset nature and overturn the sciences. They seemed to forget that the increase of known truths stimulates the investigation, establishment, and growth of the arts; not their diminution or destruction.

Showing a greater fondness for their own opinions than for truth, they sought to deny and disprove the new things which, if they had cared to look for themselves, their own senses would have demonstrated to them. To this end they hurled various charges and published numerous writings filled with vain arguments, and they made the grave mistake of sprinkling these with passages taken from places in the Bible which they had failed to understand properly, and which were ill suited to their purposes.

. . . Men who were well grounded in astronomical and physical science were persuaded as soon as they received my first message. There were others who denied them or remained in doubt only because of their novel and unexpected character, and because they had not yet had the opportunity to see for themselves. These men have by degrees come to be satisfied. But some, besides allegiance to their original error, possess I know not what fanciful interest in remaining hostile not so much toward the things in question as toward their discoverer. No longer being able to deny them, these men now take refuge in obstinate silence, but being more than ever exasperated by that which has pacified and quieted other men, they divert their thoughts to other fancies and seek new ways to damage me.

. . . Possibly because they are disturbed by the known truth of other propositions of mine which differ from those commonly held, and therefore mistrusting their defense so long as they confine themselves to the field of philosophy, these men have resolved to fabricate a shield for their fallacies out of the mantle of pretended religion and the authority of the Bible. These they apply, with little judgment, to the refutation of arguments that they do not understand and have not even listened to.

First they have endeavored to spread the opinion that such propositions in general are contrary to the Bible and are consequently damnable and heretical. . . . Hence they have had no trouble in finding men who would preach the damnability and heresy of the new doctrine from their very pulpits with unwonted confidence, thus doing impi-

ous and inconsiderate injury not only to that doctrine and its followers but to all mathematics and mathematicians in general.

... They go about invoking the Bible, which they would have minister to their deceitful purposes. Contrary to the sense of the Bible and the intention of the holy [Church] Fathers, if I am not mistaken, they would extend such authorities until even in purely physical matters—where faith is not involved—they would have us altogether abandon reason and the evidence of our senses in favor of some biblical passage, though under the surface meaning of its words this passage may contain a different sense.

I hope to show that I proceed with much greater piety than they do, when I argue not against condemning this book, but against condemning it in the way they suggest—that is, without understanding it, weighing it, or so much as reading it. For Copernicus never discusses matters of religion or faith, nor does he use arguments that depend in any way upon the authority of sacred writings which he might have interpreted erroneously. He stands always upon physical conclusions pertaining to the celestial motions, and deals with them by astronomical and geometrical demonstrations, founded primarily upon sense experiences and very exact observations. He did not ignore the Bible, but he knew very well that if his doctrine were proved, then it could not contradict the Scriptures when they were rightly understood.

... The reason produced for condemning the opinion that the earth moves and the sun stands still is that in many places in the Bible one may read that the sun moves and the earth stands still. Since the Bible cannot err, it follows as a necessary consequence that anyone takes an erroneous and heretical position who maintains that the sun is inherently motionless and the earth movable.

With regard to this argument, I think in the first place that it is very pious to say and prudent to affirm that the holy Bible can never speak untruth—whenever its true meaning is understood. But I believe nobody will deny that it is often very abstruse, and may say things which are quite different from what its bare words signify. Hence in expounding the Bible if one were always to confine oneself to the unadorned grammatical meaning, one might fall into error.

... Now the Bible, merely to condescend to popular capacity, has not hesitated to obscure some very important pronouncements, attributing to God himself some qualities extremely remote from (and even contrary to) His essence. Who, then, would positively declare that this principle has been set aside, and the Bible has confined itself rigorously to the bare and restricted sense of its words, when speaking but casually of the earth, of water, of the sun, or of any other created thing? Especially in view of the fact that these things in no way concern the primary purpose of the sacred writings, which is the service of God and the salvation of souls—matters infinitely beyond the comprehension of the common people.

This being granted, I think that in discussions of physical problems we ought to begin not from the authority of scriptural passages, but from sense-experiences and necessary demonstrations. ... Nothing physical which sense-experience sets before our eyes, or which necessary demonstrations prove to us, ought to be called in question (much less condemned) upon the testimony of biblical passages which may have some different meaning beneath their words.

... I do not feel obliged to believe that that same God who has endowed us with

senses, reason, and intellect has intended to forgo their use and by some other means to give us knowledge which we can attain by them. He would not require us to deny sense and reason in physical matters which are set before our eyes and minds by direct experience or necessary demonstrations.

... It is obvious that such [anti-Copernican] authors, not having penetrated the true sense of Scripture, would impose upon others an obligation to subscribe to conclusions that are repugnant to manifest reason and sense, if they had any authority to do so. God forbid that this sort of abuse should gain countenance and authority, for then in a short time it would be necessary to proscribe all the contemplative sciences. People who are unable to understand perfectly both the Bible and the sciences far outnumber those who do understand. The former, glancing superficially through the Bible, would arrogate to themselves the authority to decree upon every question of physics on the strength of some word which they have misunderstood, and which was employed by the sacred authors for some different purpose. And the smaller number of understanding men could not dam up the furious torrent of such people, who would gain the majority of followers simply because it is much more pleasant to gain a reputation for wisdom without effort or study than to consume oneself tirelessly in the most laborious disciplines.

René Descartes: from The Discourse upon Method

René Descartes (1596–1650) was a versatile French philosopher and mathematician. Not only did he criss-cross Europe as a soldier during some of the campaigns connected with the Thirty Years' War, he made several important scientific discoveries as well. His meditations ruined the medieval scholastic methods and laid the foundations for modern philosophy by suggesting a new principle for the use of reason in metaphysical matters. This method, generally known as Cartesianism, is summarized as follows: "In order to get at truth, we must at least once in a lifetime get rid of all received [accepted] opinions, and reconstruct completely afresh, from the ground up, all the systems of our knowledge."

Descartes's work reflects a newly critical attitude to evidence and to ideas. Doubt had existed before: a hundred years earlier, Montaigne had represented the amiable but unconstructive doubt of the worldly-wise skeptic. But now doubt was to be used rationally, according to critical rules of evidence which would serve as an instrument of knowledge. This was the time when scientific attitudes were born, with William Harvey in medicine, Richard Simon in biblical exegesis, and Mabillon in historical criticism presenting the typical attitudes of the future.

PART FIRST

... My design is not to point out the method which everyone must follow for the right direction of his understanding, but merely to show how I have attempted to