Newton, Isaac

A central figure in the foundation of modern physics, mathematics, optics and the scientific method, Isaac Newton (1642-1727) was born in the Lincolnshire hamlet of Woolsthorpe on Christmas Day. Newton matriculated at Trinity College, Cambridge in 1661, receiving there his BA (1665) and MA degrees (1668). He became a Fellow of the College in 1667 and in 1669, at the age of twenty-six, was appointed Lucasian Professor of Mathematics. Election to the Royal Society followed in 1672. In 1696 Newton relocated to London, where he became Warden and then Master of the Royal Mint. He was elected President of the Royal Society in 1703 and knighted in 1705.

Newton's greatest discoveries and innovations came during his Cambridge years. In the mid-1660s he developed the calculus. His 1672 paper on colours confirmed the heterogeneous nature of light. The early 1670s also saw him construct the first practical reflecting telescope. In the following decade, the mathematical physics of the <u>Principia mathematica</u> (1687) yielded spectacular results: the laws of motion, the inverse-square law of universal gravitation, elegant mathematics to underpin astronomy and physics and the unification of terrestrial and celestial mechanics. In the three editions of this work he also developed principles of an inductive method that still serve science today. The <u>Principia</u> is the grandest achievement of seventeenth-century mechanical philosophy and one of the most revolutionary books in the history of science. Newton's <u>Opticks</u> (1704) codified earlier research and placed optics on a firm footing; its later editions helped establish an experimental agenda for the subsequent decades. As President, Newton reinvigorated the experimental programme of the Royal Society. His first curator of experiments, Francis Hauksbee, Sr., developed an electro-static machine that helped foster the study of electricity in the eighteenth-century. His second curator, John

Theophilus Desaguliers, exemplified the Baconian ideal of producing useful knowledge through liaising with proto-industrialists, developing mine ventilation machines and employment as a waterworks engineer on the Thames.

Newton's association in popular consciousness with a deterministic and purely mechanical cosmos notwithstanding, the image of the author of the Principia as a rationalist proponent of a clockwork universe is a wishful construction of Enlightenment apologists who re-crafted Newton into their own mould. Newton's natural philosophical ethos instead conforms more closely to Renaissance ideals. He was committed to the goal of recovering the prisca sapientia (ancient wisdom), believing that the ancients had held superior forms of knowledge that could and should be recovered. Newton's public and private writings show that he rejected a clockwork universe, holding instead to a providentialist view of the cosmos in which God periodically intervenes to keep Nature on course. Newton's supporter Samuel Clarke eloquently supported these ideas in his famous correspondence (1715-1716) with the German philosopher Gottfried Leibniz. Newton also worked to reintroduce spirit into natural philosophy. What is more, his surviving papers reveal that he was not only a practising alchemist, but that he devoted more time and energy to the study of theology and prophecy than to natural philosophy.

These commitments did not remain in a separate intellectual sphere, but played a role in shaping Newton's metaphysics and his natural philosophical style. An example is seen in his adherence to a form of epistemological dualism in which knowledge is divided up into two categories. Lower, relative forms of knowledge are accessible to the vulgar, while higher, absolute forms of knowledge can only be penetrated by the adept—a distinction seen in the thought of the Pythagoreans, Plato, Maimonides, the alchemical tradition and, Newton believed, the Bible.

Accordingly, Newton emulated the coded literary style he believed was used by the Hebrew prophets and the Pythagoreans in order to limit access to his meaning that only the "wise" would understand (Daniel 12:10). This helps explain why so many had so much difficulty understanding his Principia. Newton once explained that "to avoid being baited by little Smatterers in Mathematicks . . . he designedly made his Principia abstruse; but yet so as to be understood by able Mathematicians".

The distinction between the relative and the absolute plays a role in his physics as well. In the Scholium to the Definitions at the beginning of the Principia, Newton distinguishes relative space and time from absolute space and time. Absolute space is rigid and immovable, while "absolute, true and mathematical time" flows evenly and uniformly; both exist "without reference to anything external". In contrast, the space and time of sensation and measurement are relative or relational. Thus he writes in the Scholium: "Accordingly, those who there interpret these words [time, space, place, motion] as referring to the quantities being measured do violence to the Scriptures. And they no less corrupt mathematics and philosophy who confuse true quantities with their relations and common measures". By alluding to biblical hermeneutics, Newton hints at a link between theology and science. For Newton, absolute space and time are predicates of God's omnipresence and eternal duration, an idea he developed from biblical theology, Stoicism, Philo and Rabbinical thought. As a reflection of this, Newton suggested in private that God's omnipresence might be the cause of gravity, something that would help explain the universal nature of the phenomenon.

In the Rules of Reasoning laid out in the Principia Newton advocates an inductive approach to the study of Nature. This approach is also commended in the General Scholium, where he expresses a nescience of substance and states that his natural philosophy does not extend beyond a description of the phenomena. It is enough for him that he is able to describe the phenomenon of universal gravitation mathematically; as for the ultimate cause of gravity, he famously declares: "I feign no hypotheses" (hypotheses non fingo). Both the inductive method and the derogation of frivolous hypotheses are outlined in Query 31 of the Opticks: "As in Mathematicks, so in Natural Philosophy, the Investigation of difficult Things by the Method of Analysis, ought ever to precede the Method of Composition. This Analysis consists in making Experiments and Observations, and in drawing general Conclusions from them by Induction, and admitting of no Objections against the Conclusions, but such as are taken from Experiments, or other certain Truths. For Hypotheses are not to be regarded in experimental Philosophy". Natural philosophical reasoning should be a posteriori rather than a priori.

But Newton does not reject the use of hypotheses outright; instead, he eschews the dreaming up of vain and unwarranted hypotheses, especially those that lead to system building. It is a pointed attack against the French philosopher René Descartes. For Newton, as for his most passionate disciples, there are also moral corollaries to scientific method. In Roger Cotes' preface to the second edition of the Principia the Newtonian inductive method is contrasted with the speculative-hypothetical approach: "Those who take the foundation of their speculations from hypotheses, even if they then proceed most rigorously according to mechanical laws, are merely putting together a romance, elegant perhaps and charming, but nevertheless a romance".

Similarly, the Scottish Newtonian Colin Maclaurin compares Newton's inductivism with "that pride and ambition, which has led philosophers to think it beneath them, to offer anything less to the world than a compleat and finished system of nature; and, in order to obtain this at once, to take the liberty of inventing certain principles and hypotheses, from which they pretend to explain all her mysteries". This method Maclaurin likens to beginning "at the summit of the scale, and then, by clear ideas, pretend[ing] to descend though all its steps with great pomp and facility, so as in one view to explain all things". Instead, Newton's experimental method, which begins with analysis before progressing to mathematical synthesis, is the better approach to truth in natural philosophy, even though "the beginnings are less lofty", because "the scheme improves as we arise from particular observations, to more general and most just views".

Right science must be preceded by and coupled with right method. Natural philosophical arrogance and presumption leads to error, corruption and systems constructed out of thin air. Newton's followers championed the inductive method that prioritized gathering empirical evidence as a humble technique in contradistinction to the intellectual hubris exemplified by the Cartesians.

Newton was convinced that similar methods would also lead to a recovery of true, biblical doctrine and the teachings of the primitive Christians. Rather than shape Scripture to fit a priori theories, Newton believed God's truth should be drawn directly from a close reading of the Bible. This project led him to reject several central orthodox teachings as doctrinal corruptions, including the Trinity and the immortality of the soul. Newton distained the fourth-century hypothetical and ontological discussions of the substance of God that distorted the unipersonal God of the Bible into the Trinity—a doctrine that he saw as little better than polytheism. By the standards of his day, such conclusions made him a heretic and brought the need for caution and circumspection. Nevertheless, Newton covertly attacked the Trinity in his General Scholium. That this attack appeared with an overt challenge to Cartesian planetary vortex theory helps shows that for Newton corruption in natural philosophy was linked to corruption in religion. The inductive approach extended to his prophetic interpretation, and there are striking parallels between his Rules of Reasoning and a series of prophetic rules he developed earlier in the 1670s.

Newton applied an inductive approach to his natural philosophy as well, writing in one manuscript that "God is know from his works". Newton was convinced that an inductive programme in natural philosophy would lead to God. Near the end of Query 28 in the Opticks Newton argues that "the main Business of natural Philosophy is to argue from Phænomena without feigning Hypotheses, and to deduce Causes from Effects, till we come to the very first Cause, which is certainly not mechanical". Likewise, at the end of his discussion of God in the General Scholium, Newton asserts that "to treat of God from phenomena is certainly a part of natural philosophy".

Although Newton recognized disciplinary distinctions, ultimately for him there were no impermeable barriers between philosophy, physics and faith. Because Newton was committed to the topos of the Two Books, namely, that God had "written" both the Book of Nature and the Book of Scripture, he believed that truth ultimately comes from the same divine source and thus is one. This explains why Newton highlights moral and religious corollaries to the study of Nature in the conclusion of his Opticks: "And if natural Philosophy in all its Parts, by pursuing this Method, shall at length be perfected, the Bounds of Moral Philosophy will be also enlarged. For so far as we can know by natural Philosophy what is the first Cause, what Power he has over us, and what Benefits we receive from him, so far our Duty towards him, as well as that towards one another, will appear to us by the Light of Nature." Whether in science or religion, Newton believed that the inductive method would led to purity and truth.

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