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The Strangest Piece of News

Sir Henry Wotton, the English Ambassador to the Republic of Venice, was taking a risk when he wrote to the Earl of Salisbury, sending King James I what he called 'the strangest piece of news' that the King had 'ever yet received from any part of the world'. The news came in the Latin booklet he enclosed, entitled *The Sidereal Message* (*Sidereus Nuncius*) (3: 53–96. The reference is to volume 3, pages 53–96 of the *Edizione Nazionale* of Galileo's works).[1] He had not wasted any time: the work, written by the mathematical professor at Venice's University of Padua, had appeared that very day, 13 March 1610. Though Wotton did not name the author, Galileo Galilei, he described the sensational news briefly and accurately. The professor had used an optical instrument, which enlarges objects and brings them nearer; the instrument was invented in Flanders but improved by the professor. With his instrument he had 'discovered four new planets rolling about the sphere of Jupiter, besides many other unknown fixed stars'. He had settled the long disputed nature of the Milky Way and found that the Moon is not perfectly spherical 'but endued with many prominences' and, strangest of all to Wotton, illuminated with the Sun's light reflected from the Earth: Wotton was not sure he had got this last point right, or perhaps not sure that it was credible, for he adds 'as he seemeth to say'. But the upshot was that all astronomy and astrology had been overturned – according to Wotton, rather than the booklet itself – and naturally all corners of Venice were full of the news. Before concluding by promising to send one of the new instruments by the next ship, Wotton realized that in the next post he might have to admit that he had been a credulous fool, so he covered himself neatly against this risk by saying: 'And the author runneth a fortune to be either exceeding famous or exceeding ridiculous.'[2]

We are so accustomed to Galileo's exceeding fame that it is useful to remember that it was his telescopic discoveries that made him famous. If he had died a year earlier at the age of forty-five, he would now be known only to historians of science. He would not be completely forgotten: in fact, much of the work on which his enduring fame rests was already well advanced before he ever heard of the new optical instrument, but it had not got beyond rough working papers which were known only to a few friends. He did have some reputation in Italy and abroad for his well-designed and handsomely crafted calculating instrument, the geometrical compass, with its printed manual of instructions. His position was an honourable one, mathematical professor at the renowned University of Padua, and he was becoming useful to the rulers of his native Tuscany. Even if he had died prematurely there were pupils and friends who would have kept his memory alive for a while. Sooner or later scholars would have come across him and, if the manuscripts of such a person had survived, perhaps a local society would have been founded to reconstruct his discoveries. But he would never have been famous.

His reputation would be very much like that of his contemporary, the Englishman Thomas Harriot (1560–1621), who had observed the Moon through a telescope and made a drawing of it on 5 August 1609, when Galileo had not got beyond showing how much could be seen on land and sea with his telescope.[3] Harriot was a versatile genius: English people can compare him with Galileo without fear of being accused of chauvinism. Nor did he keep his discoveries entirely to himself: he had his friend, Sir William Lower, observing the Moon through all its phases just at the time Galileo was observing the newly discovered satellites. Lower was able to see in the new Moon the earthshine that Wotton was to find so strange and he thought the full Moon looked 'like a tarte that my Cooke made me the last Weeke – here a vaine of bright stuff, and there of darke, and so confusedlie all over'.[4] But, though Harriot was a major innovator in mathematics and physics, he did not publish his findings, whereas Galileo did.

Not only did Galileo publish his telescopic discoveries, he did so before anyone else produced anything on the subject and he followed them up with more; from this time on he displayed the rare gift of popularizing his views in language that any educated person who was not completely set against new ideas could enjoy and more or less

1 Galileo: the frontispiece of Viviani's *De locis solidis* (Florence, 1701).

understand. He also had a very good conceit of his own amazing abilities and was to find it difficult to allow others a share in the glory that he thought was his alone. He is most widely remembered for his brilliant but unsuccessful campaign to use the novel telescopic discoveries to gain acceptance for the (more or less) Sun-centred system of the universe proposed decades earlier by Nicolaus Copernicus (1473–1543) in his *De Revolutionibus Orbium Coelestium* of 1543. The first set-back to Galileo's campaign came in 1616, only a few years after he discovered the planets rolling about Jupiter: the Congregation of the Index ruled that Copernicanism could be treated by Catholics only as a calculating device. For Galileo himself, though not for his cause, the definitive defeat came in 1633 when he was condemned by the Roman Inquisition for his flawed but fascinating *Dialogue on the Two Chief World Systems (Dialogo sopra i due massimi sistemi del mondo)*, which compared the geocentric approach of Ptolemy with the heliocentric system of Copernicus. That notorious condemnation has made Galileo into an enduring symbol of scientific freedom and an embarrassing famous son to his own Church. It is remarkable that in his declining years, despite bereavement, approaching blindness and humiliating restrictions on his freedom of movement and association, he was able to draw together and complete his earlier pioneering studies, particularly on motion, in his greatest work, the *Discourses on Two New Sciences* (*Discorsi e dimostrazioni matematiche intorno a due nuove scienze*) of 1638.

Even the brief sketch in the preceding paragraph is sufficient to raise the question: how should Galileo's life be presented to modern readers who perhaps know little of him beyond the notion that he is a founder, perhaps the founder, of modern science? Stillman Drake, whose publications have done a great deal over recent decades to draw attention to how Galileo actually worked, has no doubt: 'The most faithful portrait of Galileo as a scientist is one that shows him in the role of the pioneer modern physicist, and not in that of an over-zealous Copernican astronomer.'[5] There is a good deal to be said for Drake's view. Much of Galileo's enduring reputation rests on his having pioneered ideas which have been enormously fruitful in physics. Galileo himself knew that he was starting something new. But the fact remains that he deliberately devoted a large part of two whole decades to furthering Copernicanism, decades in which, apart from ill health, he was at the height of his intellectual powers. During those decades he did not respond to the occasional urgings of a few knowledgeable friends to complete his studies of how bodies move on or near the Earth. This may be a matter for regret, but it is what happened. It is, of course, important not to read the first forty-five years of his life as though they had been leading up to the public espousal of Copernicanism in 1610. Galileo *was* looking to escape from the daily tedium of humdrum teaching but he was no Churchill, fretting away his powers until the moment of destiny should arrive; in any case, astronomy had never occupied the chief place in his studies. Drake is also right to insist that Galileo's work in physics is of greater significance for later science than anything, however impressive, which he contributed to astronomy.

Yet his campaign to establish Copernicanism included a major contribution to physics, namely the unseating of Aristotelian philosophers, who hitherto had assumed they were the final court of appeal on what motion is. An essential step was to reduce them to mere members of a divided jury and to show them that their case against a moving Earth was not proven. This Galileo was to do in the most important section of his *Dialogue* of 1632, so there need be no distortion or downgrading of physics in following Galileo's life as it comes: samples of his work in physics can still be introduced in their proper place and their lasting significance can be indicated. By the same token, this brief biography will give a good deal of space not just to Galileo's astronomy and physics but also to his ways of dealing with philosophical and theological questions. It may seem to some that such topics are not strictly relevant to the history of science. That seems to me an artificial compartmentalization, but in any case they certainly seemed relevant to Galileo. The man who wanted to establish a new approach to natural philosophy and a new system of the world could not avoid such questions, even if, as seems clear, he knew that the crucial area was physics, especially the physics of motion.

One good way to introduce Galileo's treatment of all these topics to modern readers is to make the most of the clear, forceful and exciting expositions which he wrote for the educated public of his time. There is a great deal of controversy about his personality, originality, scientific judgement and philosophical ideas. The vast scholarly literature about him contains few topics of importance that are undisputed in their interpretation, but it is generally acknowledged that he was a great writer and teacher – though even as a teacher he is often accused of oversimplification and sometimes of dishonesty. The sudden fame that followed *The Sidereal Message* provided Galileo with the platform to display his remarkable gifts. He seized this heaven-sent opportunity to reshape his life. Certainly there is much more to him than a zealous Copernican astronomer – whether he was overzealous will appear in the following chapters. But it was Galileo himself who chose to concentrate his powers on campaigning for the acceptance, or at least the toleration, of the Copernican world-system. A biographical sketch which gives prominence to that campaign, with all its philosophical, theological and ecclesiastical consequences, is simply respecting the choice which Galileo made. Nor was it a foolish choice, though it turned out to be an unlucky one. The strategy of the campaign took in not only the promotion of Copernicanism but also fundamental ques-

2 Galileo, from *Serie di ritratti d'uomini illustri toscani*, volume 2 (Florence, 1768).

tions of how science should be approached, questions which needed tackling if physics was ever to be emancipated from Aristotelian philosophy. His life would be simpler to write if the unhappy consequences of his commitment to Copernicanism could be given a brief mention and then disregarded, as he taught us to disregard air resistance in the free fall of heavy bodies. But that simpler life would not be

Galileo's. He was not in free fall: he was freely grasping opportunities, responding to difficulties and circumventing constraints. He was not in a vacuum: he was in a sophisticated and learned culture which found many of his views, in the expressive contemporary phrase, 'very impersuasible'. To persuade his contemporaries became his goal, soon after he had caught their attention with his *Sidereal Message*.

The 'Novelist'

There was always the chance, which in 1610 Wotton had to take seriously though we no longer can, that Galileo would turn out to look 'exceeding ridiculous'. *The Sidereal Message* did not declare openly for Copernicanism in so many words, but it gave very broad hints of the way Galileo was thinking. In the dedication to Cosimo II, the Grand Duke of Tuscany, he called the Sun 'the centre of the world' (3: 56). In the body of the booklet he referred three times to a book he hoped to publish on the system of the world (3: 73, 75, 96). The second mention promised full proof of the earthshine for those who thought the Earth must be excluded from the heavenly dance because it is devoid of motion or light: he would confirm by proof and argument that it is wandering and brighter than the Moon. It is only the casualness of this incidental remark that makes it count as a broad hint rather than a declaration. The third mention came in his concluding paragraph, where Galileo said that Jupiter's satellites – to use the name Kepler gave them before the year was out – provide a fine argument for removing an objection to the Copernican system. The objection was that Earth had to carry the Moon round with it as it circled the sun and this seemed to some anomalous, or even impossible. The objection disappeared since there was no doubt that, whether Jupiter circled the Sun or the Earth, it certainly carried four planets with it (3: 95). Nor could anyone continue to claim that all heavenly motions were centred on the Earth, since the motions of the satellites were centred on Jupiter. So, though Galileo did not declare outright that Copernicus had found the true system, what he wrote was very significant: it amounted to transferring Copernicanism from the class of mere calculating devices available to astronomers and putting it squarely among rival views for the true constitution of the universe (see chapter 2). To that extent, it can be said that it was Galileo who made non-astronomers take Copernicanism seriously. *The Sidereal Message* gave fairly unmistakable hints that that was what he intended to do.

Not all readers would take those hints, but none could miss Galileo's definite claim that human vision had gained its first increase in power since the creation of the world; more would now be visible than humankind had ever had access to. It is tempting to say that it could now be *seen* that the Moon was not perfectly spherical, as a heavenly body should be; but Galileo knew very well that it took seeing and reasoning combined to establish that conclusion (3: 62–3; 10: 273). Still, he was quite confident that he could show that the Moon is disconcertingly like our Earth, which almost everyone thought was a unique, fixed body at the centre of the universe, surrounded by the elements of water, air and fire. The defining characteristic of all heavenly bodies, in common estimation, was precisely that they were like nothing on Earth. Yet Galileo was saying that the Moon had mountains and valleys very like those on Earth. The great Hellenistic astronomer, Ptolemy, writing about AD 150, had thought that to treat the Earth as moving was quite laughable.[6] Galileo would soon try to show that to accept that the Earth is moving, is in fact a planet, was the only satisfactory approach. Wotton would not have thought so far ahead, but he could certainly see that the essential split between Earth and heavens was being challenged. Such a challenge, it was reasonable to point out, might well turn out to be ridiculous. A good deal of Galileo's work in both astronomy and physics, both before and after 1610, was devoted to transforming the obviously ridiculous into the ridiculously obvious, a fact which makes it quite difficult for us to understand and appreciate not only the strengths and weaknesses of the views he wished to overthrow, but also the successes and shortcomings of his own approach.

There is no doubt, as Wotton perceived, that *The Sidereal Message* announced something very new. If one could use a seventeenth-century English term without misleading people, Galileo could be called 'a novelist': whether by experience or temperament he was fascinated by *new* discoveries, by novelties in theory and practice. His own debt to ancient and medieval thinkers is something which will be touched on as his story unfolds, and he prided himself on continuing the work of Archimedes (287–212 BC), the greatest mathematician of antiquity. But he was certainly an innovator and took equal pride in that. It is not exaggerated to say that his *Sidereal Message* told people that a new age had begun and that the way the universe was studied would never be the same again.[7] In that sense the little book can fairly be called revolutionary. But Galileo's tract, indeed all his work, has to be seen against a wider background if we are not to be beguiled by the easy use of labels like 'the scientific revolution'.

'The Scientific Revolution'

It is still customary to talk of 'the scientific revolution': the label would naturally suggest that at some more or less specifiable period there was such a change in scientific thought and practice that it amounted to a revolution. The challenge would then be to trace the development of later science from that initial revolutionary breakthrough. A seemingly natural refinement of the project would be to concentrate attention on key disciplines, such as astronomy or physics; further refinement might allow that medicine, for instance, should not be forced into a framework designed for astronomy. Further nuances could be introduced: if the period of scientific revolution is supposed to begin, for instance, with Copernicus's *De Revolutionibus* in 1543 and end with Newton's *Principia* in 1687, still one would not have to imagine that Newton, as it were, brought down the final curtain on a completed drama and one could even concede that Copernicus did not make an entirely fresh start. (How much could be credited to 'pre-revolutionaries' without evacuating 'revolution' of all meaning is a topic of continuing debate.) One could also allow for smaller revolutions which would find their place within the one overarching revolution. In other words, 'the scientific revolution' can provide a framework in which to set the antecedents, discoveries, disputes, dead ends and cross-purposes of the sixteenth and seventeenth centuries; in such a framework Galileo could hardly be denied an important role, perhaps even a central one. It could also be said that he claimed such a role for himself: not that he talked of a scientific revolution, but he had equivalent ways of advocating a major reform of physics and astronomy and of scientific method, and he assigned himself a unique place in this reforming movement. So there is a good deal to be said for the usefulness of the label 'scientific revolution', which has been used judiciously by some of the most able historians of science.

But it has its dangers too. There is nothing wrong in tracing the development of ideas, practices, instruments, institutions or world-views that interest us now. There is nothing objectionable in the persuasion that assignable progress has been made in this or that subject in recent centuries (though philosophers would raise serious questions about the criteria of progress and the status of any claim to knowledge). But a frank pursuit of what interests us now can easily lead to a selectivity which distorts the whole context of what is being examined: what now seems to us alien or pointless is quietly passed over, while other topics or interests are too readily identified with our own. The history of science can, as a consequence, be reduced to a celebration of great scientists, with perhaps minor prizes for best supporting actors. Hindsight can make someone into a precursor or forerunner of someone else, when the simple fact is that, apart from John the Baptist, no one points to someone else who is still to come, though anyone may, as Galileo did, express the serious hope that others will build on his work.

A further danger of the label 'scientific revolution' is that it can tempt us to class people as revolutionaries or reactionaries, winners or losers, progressives or conservatives. Such simplifications are useful, perhaps essential, but they can make us miss the untidy way in which the development of science actually took place. Historians of science are well aware of this danger, but it certainly needs pointing out in any introductory treatment of Galileo's life, because he himself was very impatient with writers more cautious (and less gifted) than himself. He was very much given to grading people on a descending scale which went from free and open-minded observers of nature to servile and bookish dogmatists. Such assessments were sometimes very accurate and often presented with entertaining rhetoric, so anyone studying his life is tempted to concur uncritically with Galileo's admittedly privileged, but nevertheless highly partisan, views on contemporary scientific disputes. One can, of course, innoculate oneself against the disease of adulation by reading some of the considerable literature which sets out to cut Galileo down to size, but the dosage is a matter of dispute and some writers seem to have overdone it. None of this need force us to abandon the useful label 'scientific revolution', though I think it safer to be satisfied with calling Galileo a decisive innovator in disciplines which are important no matter what framework is chosen for the history of science. Great changes were taking place and Galileo was associated with many of them. He was not, of course, seriously involved in them all. He gave up his early study of medicine as soon as he could and his contributions to contemporary medical studies were only indirect or incidental. This false start to his career can serve to remind us that no overall picture of contemporary developments in science can be drawn merely from a study of his life. In this connection it is worth noting that 1543 also saw the publication of Vesalius's great anatomical work *De Fabrica Corporis Humani*. But a decent scepticism about the rhetoric associated with 'the scientific revolution' does not alter the fact that developments in astronomy and physics were of lasting importance. Galileo certainly made physics his own; indeed, one might say that he more than anyone else began to make it into what we now recognize as physics.[8]

But the impact he made on astronomy is rather different. He was