Atle Naess, **Galileo Galilei – When the World Stood Still,** Springer, Berlin, Heidelberg 2005.

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In popular perception, Galileo is considered to be one of the founders of modern science, a pioneer in scientific enquiry, and a symbol of intellectual freedom. More importantly, he is admired as the person who conclusively proved the Copernican heliocentric system, thanks to his discoveries with the telescope, and who propagated it more than anybody else in the first half of the seventeenth century. This brought him into conflict with the Church authorities, against whom he is supposed to have waged a bitter rebellion. Is such a black-and-white attitude warranted? Is there some myth-making involved in this? That is the subject matter of this book. It is a very human account of the life of a very great scientist of the medieval period. It is not a book specifically for scholars, nor does it offer any new insights into the scientific contents of Galileo's work (After all, there is a considerable Galileo industry, covering all aspects of his life and works). This book is an overview of the life and times of Galileo, the milieu to which he belonged, rich in details of the intrigues and twists and turns associated with his defence of Copernicanism, culminating in the Inquisition trial. It is meant for the educated lay person, who is not satisfied with certitudes and who wants to go beyond popular truths.

The book is divided into seven chapters, not counting the prologue and epilogue. It gives a graphic account of Galileo's family background, of Florence and Medicis, and the intellectual and politico-religious atmosphere in Europe in general, and Rome-Florence-Venice in particular. Galileo's father was a musician, who appears to have conducted experiments on the relationship between the pitch and tension of strings. This approach, particularly his practical attitude to mathematics as a working tool, had a decisive influence on Galileo. Galileo began as a student of medicine in Pisa university, but was more interested in mathematical subjects. It is during this period that he is supposed to have observed the oscillations of a chandelier in the Pisa cathedral, and came to the conclusion that the time period was independent of the amplitude of oscillations. Galileo was appointed to the chair of mathematics at Pisa university at the age of 25 in 1589.

His experiments on falling bodies from the leaning tower of Pisa clearly showed that balls made of different materials took approximately the same time to fall to the ground. This led him to abandon Aristotelian notions, and take an Archimedean approach to the problem. He was openly critical of Aristotle and "made sure he provoked his colleagues at Pisa on a more personal level". This was to be his style throughout his life.

The most productive period of Galileo's scientific life (and indeed personal life too) was in Padua from 1592-1610, where he was a professor in the university. It is here that he conducted his experiments with inclined planes, formulated his law of falling bodies that the distance traveled is proportional to the square of the time, and that the trajectory of a projectile is a parabola. A coherent account of all these was to be published much later. He also designed a 'geometric and military compass' .

It was at the end of his eventful career in Padua that he constructed his own telescopes, and made his famous observations on the irregular surface of the Moon, Sunspots, phases of Venus, on Saturn, and the moons of Jupiter. The author's account of the discovery of objects around Jupiter, and how Galileo came to the conclusion that they were in fact Jupiter's moons is gripping and lucid. He named them as 'Medicean stars' and described them in a little book *'Sidereus Nuncius'* (*'The Sidereal Messenger'*), which he dedicated to Cosimo II de Medici, the grand duke of Tuscany. Galileo always courted the high and mighty in the land, particularly the powerful Medici family in Florence, and counted upon their influence to accomplish various things. He was rewarded with an appointment as 'Mathematician and Philosopher' of the grand duke of Tuscany, with a high salary. His earlier appointments at Pisa and Padua were also due to the intervention of influential people. But that seemed to be the order of the day in those times, and even now to some extent.

Johannes Kepler, a contemporary of Galileo already famous for his laws of planetary motion, was quick to realise the importance of Galileo' s discoveries. Satellites orbiting Jupiter would demonstrate that Earth was not the centre of all cosmic motion, thereby strengthening Copernicanism. One of the arguments against Earth's motion in those days was the following: if the Earth moved around the Sun, the Moon would be left behind. Now, this argument would be untenable. If Jupiter could orbit around a centre (Sun or Earth) without leaving behind its moons, the Earth also can move around the Sun, without leaving behind the Moon. Kepler wrote a glowing defence of Galileo and Jupiter's moons, which he himself had not seen, and sent it to Galileo. He also published a polished version of the letter in a pamphlet. "Galileo never returned the favour. He did not even reply to Kepler's letter or thank him for the favourable wind generated by the pamphlet". "Perhaps the proud Tuscan viewed upon Kepler not as a brilliant astronomer. .. but as his major rival in being the principal harbinger of the Copernican truth in Europe". This was another trait of Galileo. Similarly, he never gave any credit to Father Scheiner who had perhaps seen the sunspots earlier than Galileo, though he had wrong notions about them. Galileo was positively hostile to Scheiner, and the Jesuits close to the Father played a prominent role in the Galileo trial later on.

The author gives a graphic account of the role of the Roman Catholic church, especially the Jesuit order and the Roman Inquisition, during the sixteenth and seventeenth centuries. The Jesuit order greatly emphasized teaching and scholarship, and literally conquered higher education. But they were closely associated with the Inquisition which did not hesitate to put to death persons proven to be heretical. The book gives a chilling account of burning at stake of Giordano Bruno, a Copernican among other things.

Galileo's telescopic discoveries catapulted him into fame. He was not yet in the line of fire of the church. His lectures in Rome in 1611 in the Jesuit college's great hall were a roaring success. Among the people won over by the lectures was Maffeo Barberini, later to become Pope Urban VIII.

Galileo was aware that the idea of Earth's motion was against certain passages in the Bible, but his success emboldened him to think that any misunderstanding between cosmology and biblical passages ought to be clarifiable. In his *'Letter to Castelli'*, he used a "subtle line of argument to try to show that the passage could be read as a justification for Copernicus". He expanded his version in his *"Letter to the Grand Duchess Christina"*. In a letter to Cardinal Casini, Galileo also advanced the idea that the phenomenon of tides could be explained by Earth's motion. But the arguments were erroneous as confessed by Galileo himself later. But the tide in Rome was against the Copernican theory, and in 1615 Kepler's *Epitome of Copernican Astronomy* and Copernicus's *De Revolutionibus* were banned. Galileo's views were also troublesome to the Church, but as he was already a celebrity and a favourite of Grand Duke Cosimo of Florence, something had to be done discretely. The Jesuit and Cardinal Robert Bellarmine , the 'Hammer of the heretics' along with Cardinal Segezzi met Galileo, and directed him not to hold or defend the Copernican theory. The Inquisition file document (unsigned) pertaining to this meeting in 1616 states that Galileo was admonished not to hold, teach, or defend the Copernican theory in any way whatsoever either orally or in writing.

Galileo was down but not out, and was hoping that things would change. He wrote *Il Saggiatore (The Assayer)* in 1623 on the nature of comets and their orbits. On comets Galileo was unsuccessful, but the book was a "springboard for a general description of nature". It is here that he formulates his belief in mathematics as the language of nature. This was already known to be true of astronomy, but he had free- fall motion, pendulum and other things also in mind.

Meanwhile Maffeo Barberini had just become Pope Urban VIII and the book was dedicated to him. *'The Discourse on the Ebb and Flow of the Sea'* marshalled all the arguments in favour of the Copernican theory, the phenomenon of tides being considered as proof of the annual and diurnal motions of the Earth. It appears that it was Pope Urban VIII who suggested a different title, and finally it was named *"Dialogue Concerning the Two Chief World Systems, Ptolemaic and Copernican"*. In this work, Galileo gathered together all the arguments in favour of the Copernican theory and against the geocentric cosmology. It got published in Florence in 1632 after a preface was inserted professing that what followed was hypothetical. But in Rome, it was viewed differently. Galileo was summoned to Rome in 1633 and had to appear before the Inquisition. The author suggests that the Pope had to appear tough, as he had been challenged earlier in the college of cardinals in the context of the European wars about whether he had the will to defend the catholic faith. In any case, he was reminded of the Inquisition in 1616. Galileo's defence was stunning. He said that the 'dialogue in no way attempted to hold, teach or defend Copernicus's theory - on the contrary it tried to repudiate it'. The commission was not convinced. Galileo was threatened of torture. He was in the Inquisition prison for a day or two. After a humiliating procession through the centre of Rome, Galileo was taken to the Dominican church in Rome, where it was pronounced that Galileo was found to be vehemently suspected of heresy and his *'Dialogue'* was banned. He was made to sign a document which recapitulated his offences and ended with " I abjure, curse, detest the aforesaid errors and heresies and generally every other error, heresy and sect whatsoever contrary to the holy church". There is no evidence that Galileo muttered "It moves all the same".

So, there we have the well-documented account of the conflict between the church and science. What strikes one foremost in this context is that it is repeatedly asserted (by extrapolation) by many in India, that the "priestly class" here too prevented the evolution of science. Where is the evidence for the conflict of interests between the religious hierarchy and the practitioners of science in ancient and medieval India, or how the former suppressed the latter? This is an aspect worth pondering over.

Be that as it may, a house arrest was ordered for Galileo after the Inquisition proceedings. But it appears that the restrictions were gradually relaxed. He was allowed to pursue his scientific work, barring anything to do with Copernicanism, though there was no question of any publication of any kind in the papal territories. In fact, he could complete his magnum opus, *Dialogue Concerning the Two New Sciences.* It is significant that this work as well as the earlier *"Dialogue"* were written in Italian. Galileo was perhaps the first major European scientist to write in a spoken language of the people rather than Latin. In the "... *Two New Sciences"* he treated for the first time, the bending and breaking of beams, and summarised his mathematical treatment of falling bodies, and the parabolic path of projectiles as a result of the mixing of two motions, one with constant speed, and the other with constant acceleration. This was his lasting contribution to science. This is because though he is remembered for the battle over the Copernican system, he is "little more than a footnote between Kepler and Newton in historical terms" in the new view of the universe. While conceding Galileo' s greatness, the author draws attention to several instances when he (Galileo) was quite opportunistic. Commenting on Galileo' s cult status, he points out that "the story of his reputation also shows that even people who distance themselves from religion on the grounds of rationalism. . . also have need of saints and martyrs".

We have a comprehensive account of Galileo' s life and times in this book. But the details of the various characters associated with the Copernican controversy and the exchanges among them can be sometimes overwhelming. Moreover, it is not correct when it stated that "He (Copernicus) knew -as did all other learned men - that the accepted Ptolemaic view of the world was hard to reconcile with precise astronomical observation". In fact, planetary positions calculated from Ptolemy's system would have tallied reasonably with observations, given the accuracy attainable at that time; in any case the Copernican system fared no better in explaining data. Also, there is some confusion in the book regarding what Copernicus achieved and the reception of his ideas in the astronomer community in Europe. In fact, though the overall framework of his model was heliocentric and was broadly correct to scale, in the words of Kepler, "Copernicus, ignorant of his own riches, took it upon himself for the most part to represent Ptolemy, not nature, to which he had nevertheless come the closest of all". It was not surprising that the Copernican heliocentric theory was not accepted by the astronomer-community in Europe, and Tycho Brahe proposed a model in which the planets orbited around the Sun, which in turn revolved around the Earth , forty years after Copernicus's death. (A model which was essentially the same as Tycho Brahe's had been proposed by Nīlakaṇṭha Somayājī, the famous Kerala astronomer earlier in 1500 AD in his *Tantrasangraha* and other works and elucidated by Jyeṣṭhadeva in his *Yuktibhāṣā* around 1530). But it is true that the Copernican system with the Sun as the centre had a certain appeal, and it is not surprising that Galileo was attracted by it. But his telescopic discoveries did not prove that the Earth is a planet orbiting the Sun, though the moons of Jupiter showed that there had to be more than one centre of motion in the universe, and the phases of Venus showed that it revolves around the Sun.

Atle Naess has written this biography in a reader-friendly, racy style and we certainly recommend it to anybody interested in the history of scientists and scientific ideas.

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