

Galileo Galilei

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The Father of Modern Astronomy

If you ask anyone who was the most influential astronomer of all time, it is a safe bet that the majority would name Galileo Galilei. His contribution to observational astronomy was immense, earning him a place as one of the greatest scientists of all time, notable for his use of the scientific method in finding out how the universe works.

"Galileo, perhaps more than any other single person, was responsible for the birth of modern science."

Stephen Hawking



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Galileo Early Life

Galileo was born in Pisa, Italy, on February 15th 1564, the son of a musician. His family were minor nobility, albeit with little wealth, and the family moved to Florence, in 1570. As a promising, intelligent student, he enrolled at the University of Pisa, in 1581, and, like so many sons of nobility, initially studied medicine. It was here that he moved away from studying medicine, mainly due to an obsession with pendulums, a need to know how they worked and

what forces caused them to swing with such regular precision.

In 1602, this study into the pendulum [1] led to his first major discovery; that the period of a pendulum does not depend upon the arc of the swing, and this discovery fuelled further study, including the development of a pendulum clock, although it is likely that his son did not build this until after his death.

The young scholar studied the physics and mathematics of the Ancient Greeks, taking in Aristotle and Euclid [2], but he questioned Aristotle's approach to falling objects. Firstly, Aristotle believed that the speed of descent of a falling object increased with weight, a finding that Galileo felt did not match reality and one that he set out to test.

He set up a series of experiments determining at what rate balls of different weight rolled down an incline, determining the position of the balls after a set time and noting that the rate was not related to the weight of the ball. In his text, *De Motis*, (On Motion), he announced his discoveries to the world.

Galileo's Telescope

In 1592, Galileo became a professor of mathematics at the University of Padua, where he made further contributions to mathematics, correctly calculating the optimum placement of oars in galleys by treating the oars as levers. He also designed other mechanical devices, a fascination that he pursued throughout his life. Alongside a pump that only required one horse to operate and shift huge volumes of water, Galileo made his telescope [3].

While there is some doubt that he made the first telescope, there is little doubt that his was a huge improvement, magnifying objects 20 times. With this, he studied the moon and discovered that Jupiter had moons, as well as verifying the phases of Venus and observing a supernova. With all of this information, he further showed that the universe was not perfect, building upon the findings of Brahe and Kepler, and he also showed that the Copernican system was largely correct, in that the earth was merely a planet that revolved around the sun. This belief would see Galileo attract the attention of the notorious inquisition.

Galileo and the Catholic Church

During Galileo's life, the Catholic Church employed the Inquisition, charged with rooting out heresy and punishing the perpetrators. Pope Paul V warned Galileo that his views against a geocentric universe were heresy, but the next pope, Urban VIII, told the scholar that he would be safe to publish his findings as long as he wrapped the ideas up as mathematical exercises rather than reality.

Unfortunately, this changed with the printing of his book, *Dialogue Concerning Two Chief World Systems*, and the scholar was called to Rome, in 1633, to face the full wrath of the Inquisition for heresy. Due to influential friends, he was spared torture and execution, but he was placed under house arrest for the remainder of his life. In 1638, almost completely blind, the scholar was allowed to move back to his home in Florence, to serve out the rest of his days under house arrest. In 1642, this intellectual giant died, leaving us with a rich legacy.

Of course, Galileo's problems with the Church are well documented, and are still the source of

much friction between science and religion. Thomas Aquinas managed to reconcile classical thought with the church, integrating the findings of the Greeks into with Catholic doctrine, but Galileo's work called even this into question.

Galileo and the Scientific Method

However, as much as we remember Galileo for his work on moving objects, kinematics, his greatest contribution was in how scientists approached science, subtly changing the underlying philosophy and overall aims of scientific research. Previously, scientists had to understand the 'why' as well as the 'how,' becoming philosophers as well as observers.

Galileo directed scientists down the path of pure observation rather than trying to explain the metaphysical aspects of phenomena, taking science away from God and theology. To a scientist, it was enough to explain that something happened, and explaining whether it was divine or physical for philosophers to answer, although many of the great scientists would contribute to philosophy and even theology throughout the Renaissance and beyond.

Galileo also quantified science; previously, a scientist merely had to show that something occurred and tie it to reality, as with Aristotle's idea that objects fell to earth because they sought their natural state. Galileo stipulated that a scientist should explain phenomena mathematically and use experimentation to prove it. A scientist should use mathematics to predict and experimentation to confirm, the first shift towards a hypothetico-deductive methodology [4].

Galileo also understood the importance of variables and that an experimenter should try to eliminate as many factors as possible; for example, with his apparatus designed to allow spheres to roll down inclines and allow him to measure the effect of gravity, he made sure that all surfaces were as smooth as possible, to reduce the effect of friction.

Galileo Biography

There is little doubt that Galileo Galilei was one of the most influential scientists of modern times, not just because of his use of the telescope and quantification of gravity. His contribution to the scientific method laid the foundations of modern science, giving direction to scientific research and moving it away from metaphysics.

Galileo and the Church Part I – IV

The Day Galileo Changed The Universe – Parts I – III

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