

### Galileo's story

Like almost everyone in sixteenth century Italy, where Galileo was born, Galileo was taught that Earth was the centre of the Universe and that other heavenly bodies were smooth, shining spheres – perfect examples of God's creation. According to the Church, any other belief would be contrary to what it said in the Bible, and therefore heresy.

However, when Galileo used his telescope to study the Moon, he observed no smoothness, but what looked like mountains and valleys. By focusing on the boundary between the dark part of the Moon and the area lit by the Sun where shadows were longest, and measuring the shadows there, he could calculate the heights of some of the mountains. He realized that the surface of the Moon was very jagged and rocky. He also thought that the dark, smoother spots on the Moon indicated seas. All these observations went against current concepts about the Moon – and they supported the forbidden belief that there were other worlds like the Earth, a belief for which Bruno had been convicted and burnt to death.

- **Why do ideas change in science?**

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As Galileo improved his telescopes, he was also able to observe Jupiter. He determined that the four 'stars' that moved with it could not be fixed stars but were four moons.

He quickly published his findings but his ideas were not easily accepted. Few people could obtain or use the high quality lenses Galileo had made to see the shadows on the Moon, or the moons of Jupiter. Experts in other countries, without Galileo's good telescopes, rejected his theories. And people were very reluctant to change their ideas about the Moon - it was part of God's heaven, so it must be smooth and perfect. Some astronomers came up with alternative suggestions – for example the Moon had an invisible crystal outer layer that was perfectly smooth – but Galileo scorned their 'convenient' theories.

One well-known European astronomer and mathematician, Johannes Kepler, thought Galileo was on the right track. Kepler borrowed a good-quality telescope and confirmed Galileo's measurements of the revolution of Jupiter's moons. Galileo shared some further discoveries with Kepler, but he used a secret code to ensure that Kepler couldn't claim the ideas as his own. One of Galileo's new discoveries gave good evidence that Venus orbited the Sun, not the Earth as had been previously thought. This supported the ideas of Copernicus but at a meeting of the Inquisition, Galileo was ordered not to teach Copernicus' Sun-centered theories but to think of them as imaginative ideas, not absolute truths. The Church also decided to alter Copernicus' book to reduce the possible damage it might have on people's faith in the Bible.

Galileo's run-in with the Inquisition was a warning to him. He was a religious man, and felt that his discoveries showed how marvelous God's creation was; he didn't intend nor want to disprove the Bible. He left Rome to live in Florence, near the convent where his two daughters were nuns, and worked on 'safer' scientific topics.

- **If Galileo believed in God, why do you think Galileo did not want to use religion to explain his observations?**

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When a new Pope was appointed, Galileo gained permission to write about his theories of the Universe – but he omitted to mention he'd previously been forbidden. He wrote *Dialogue about the Two World Systems* which came close to

mocking the Aristotelian Earth-centered model, and strongly supported the Copernican view. Galileo was tried and convicted for disobeying the Church's instructions by teaching Copernicus' views.

He agreed to make a public apology, swear that he did not believe the Earth moved round the Sun, and not publish any more books. He was allowed home after a year, to live under house arrest. The death of his eldest daughter added to his unhappiness but gradually he revived and he began working on new science ideas until his death, in 1642, at age 78.

- **Even though this story is mostly about Galileo, who else was involved in changing the way we view the moon and planets? How were they each involved?**

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- **Even though ideas can change in science, why is the change often difficult & slow?**

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