

LEVELED BOOK • V

# Galileo

MULTI  
level  
P•S•V

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## Focus Question

How do questions lead to new discoveries?

## Words to Know

astronomy  
controversial  
gravity  
heresy  
laws of nature  
measurable

pendulum  
philosophers  
revolutionary  
solar system  
sunspots  
telescope

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### Correlation

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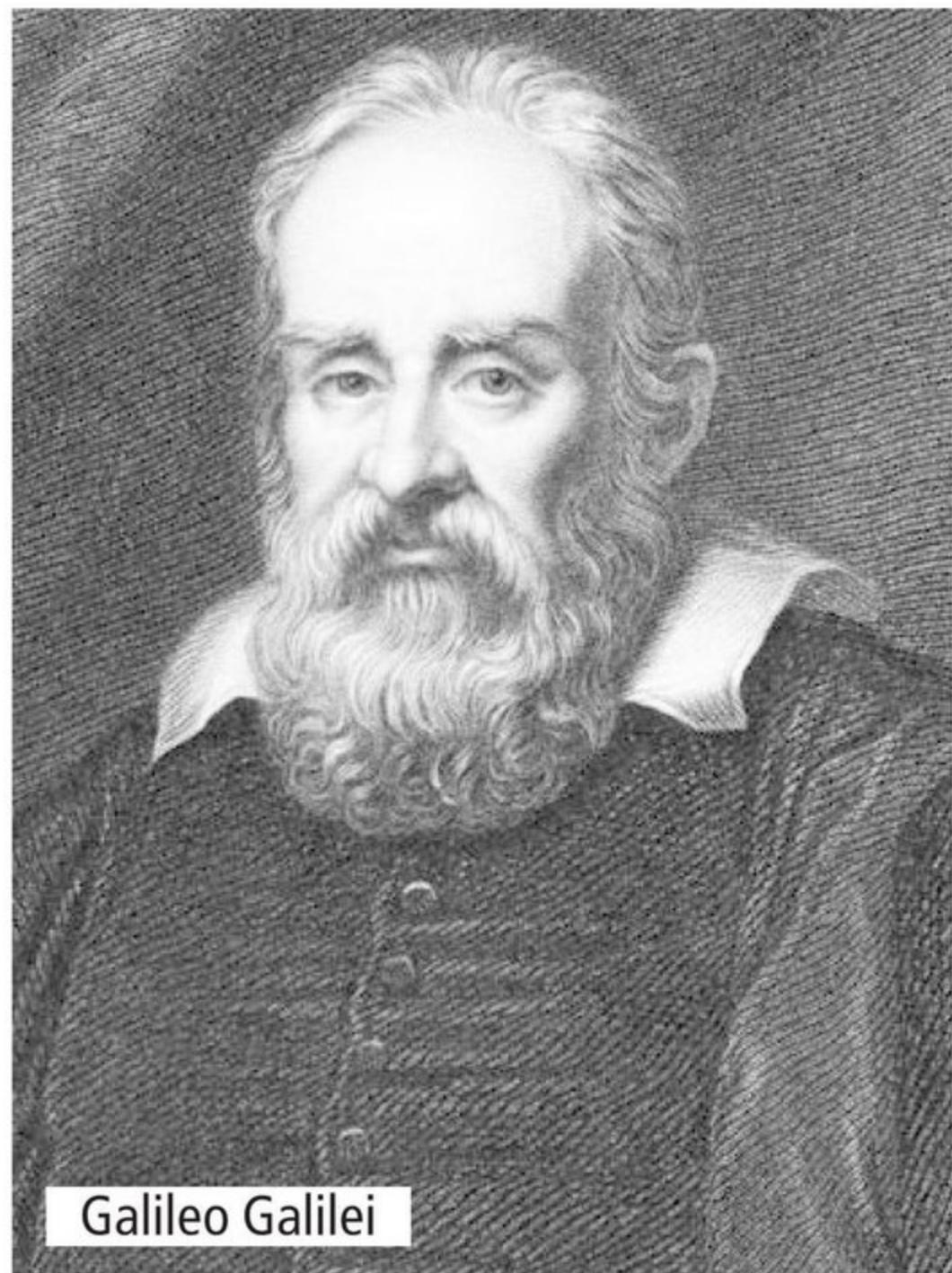
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## Introduction

What do music, the motion of a chandelier, and the planet Venus have in common? They each played a part in the discoveries of one of history's greatest scientists, a man who lived five hundred years ago. That man was Galileo Galilei.

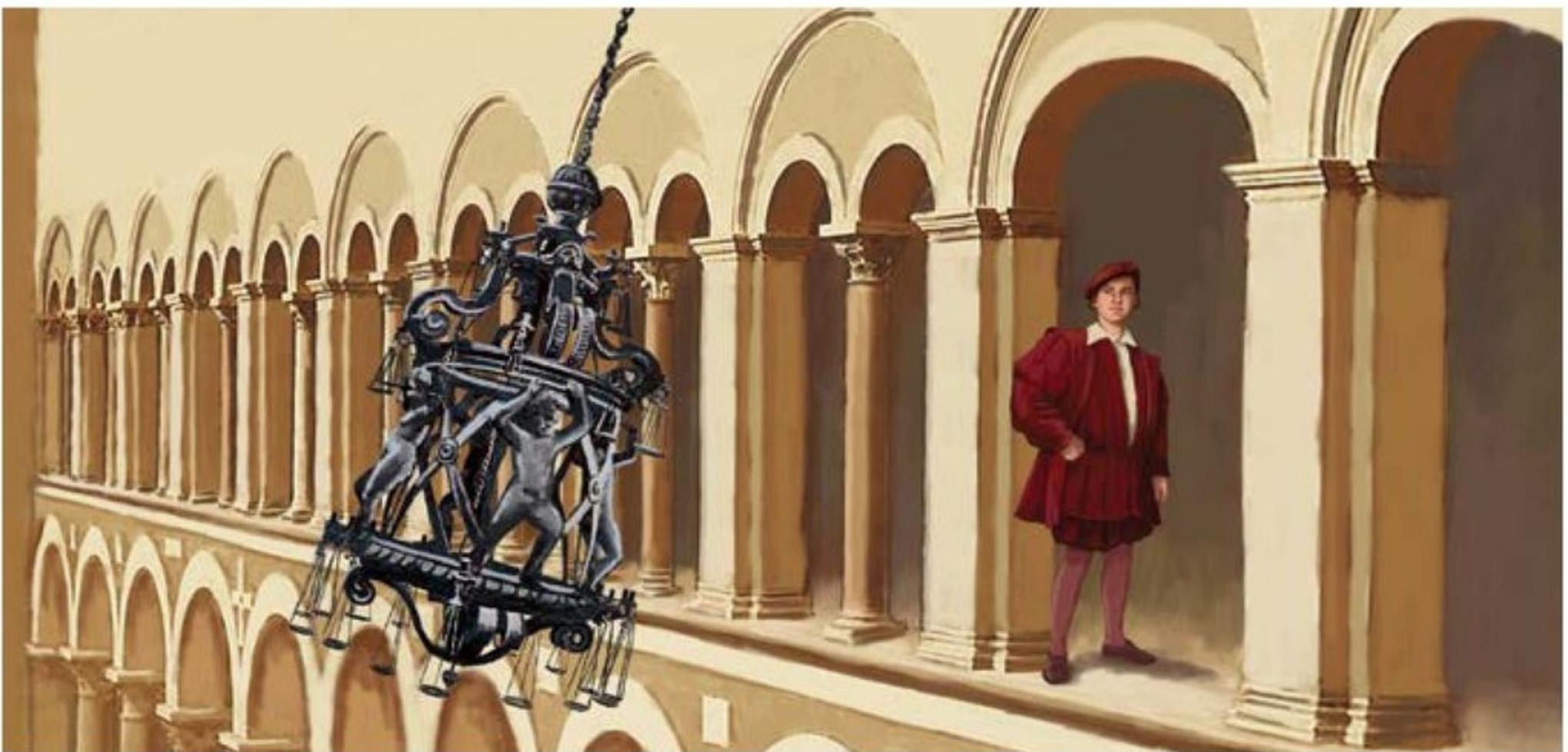
Galileo was born in Italy in 1564 during a period known as the Italian Renaissance. The Renaissance was a time of excitement and discovery. Painters, writers, mathematicians, musicians, **philosophers**, and scientists all developed new ideas during that period. Galileo was what we now call a "Renaissance man," an expert in several subjects at once. He used ideas from many sources to make scientific discoveries. Even more important, though, Galileo was good at asking questions. Though this habit eventually got him in trouble, Galileo's questions would change the way we understand the world.





## Galileo's Childhood

Galileo was the son of Vincenzo Galilei, a musician and composer. Vincenzo was curious about how music worked. He taught young Galileo to be curious, too. Galileo would remain curious all his life. His habit was to look closely at everything, record what he saw, and try to explain what he had recorded. The explanations he came up with were sometimes truly **revolutionary**.



## The Student

As a young man, Galileo became fascinated with math and physics—the scientific study of matter, energy, and motion. Physicists study the **laws of nature**, and Galileo had a gift for the work. In fact, he made one of his first major discoveries in physics a year before he entered university.

On a windy day in 1582, Galileo went to a church service. The church had a large chandelier hanging from the ceiling. He noticed that the wind outside was causing the chandelier to slowly swing back and forth. Sometimes the chandelier swung only a few inches from side to side. Sometimes the movement was much larger—as much as a few feet from side to side. But Galileo noticed something strange. Although some swings were much wider than others, every swing took exactly the same amount of time.

By watching the chandelier, Galileo discovered that a swinging **pendulum** could tell time accurately. Twenty years later, he published this discovery, and later he designed the first pendulum clock. Clocks like his are still in use today.

Despite his early achievements in math and physics, Galileo did not study math when he first entered the University of Pisa in 1583. His father urged Galileo to instead become a doctor so he would have a steady income. Galileo's medical studies never fascinated him as much as math and physics, though. Eventually, he persuaded his father to allow him to study math with a private tutor.

Galileo never finished his degree; he left university in 1585 due to money problems. For the next four years, he made his living as a math tutor. However, he did not give up his interest in science.



Grandfather clocks such as this one still use pendulums to keep time.

## The Professor

In 1589, Galileo returned to the University of Pisa to teach mathematics, and shortly afterward he was invited to teach math in Padua. He remained in Padua for the next eighteen years. During his years there, Galileo was mostly unknown. However, he continued to perform experiments. For example, he did several experiments with falling objects to test ideas about **gravity**. In the process, he proved that heavy objects fall at the same rate as lighter ones.

Galileo made important contributions to math and physics during his early career. But the discoveries that would make him famous were still to come. Galileo's most revolutionary discoveries happened when he turned his gaze toward the sky.

### Do You Know?

There is a famous story about one of Galileo's experiments. When he was a young professor, the story goes, he dropped two cannonballs from the Leaning Tower of Pisa. One cannonball was much heavier than the other, but they fell at the same speed. Today, it's not certain whether Galileo actually tossed cannonballs from the Leaning Tower of Pisa as part of his experiments with gravity.





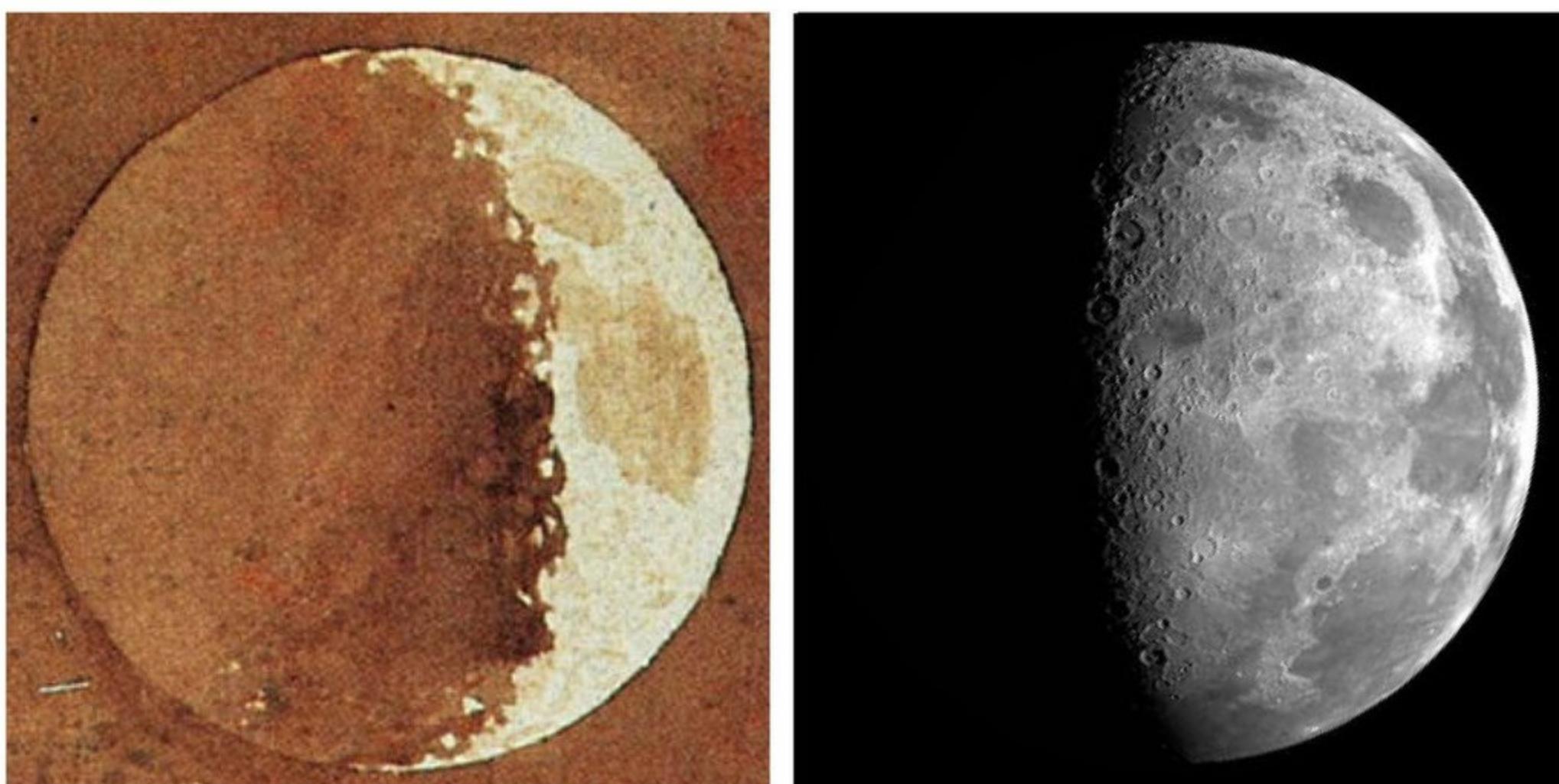
## The Astronomer

In 1609, Galileo heard about a “spyglass” invented in the Netherlands. This was a tool designed as a visual aid. When a person gazed through the spyglass, faraway objects looked much closer. Galileo had never seen a spyglass, but he was interested in the concept. He figured out how to build one, then quickly made improvements on his original design. Soon he was able to make distant objects look thirty times larger; in other words, he built a **telescope**—the most powerful in the world at that time. In a fateful decision, he began to use his telescope to study the heavens.

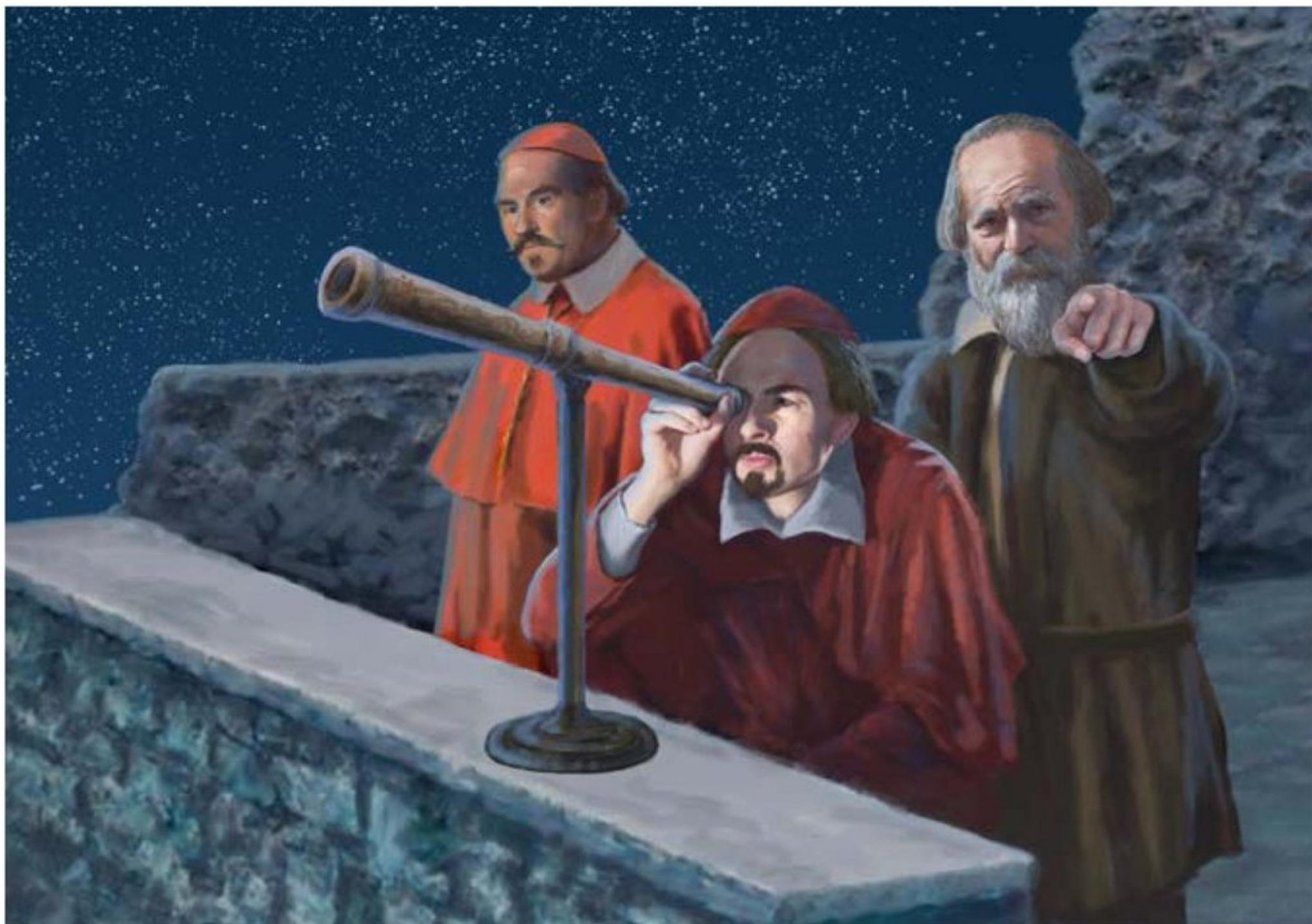
What Galileo saw through his telescope changed his life, and **astronomy**, forever.

As Galileo examined the **solar system**, he made discovery after discovery. He was the first European to observe **sunspots**. He noted that the Moon had craters on its surface. He discovered Jupiter's four largest moons. And he was the first to observe the phases of Venus. Galileo saw that Venus appeared to change shape, just as the Moon does. For example, Venus had a full phase, a new phase, and crescent phases.

Galileo published some of these discoveries in 1610 in a book called *The Starry Messenger*. The book made Galileo famous. As he would discover, though, fame had a price.



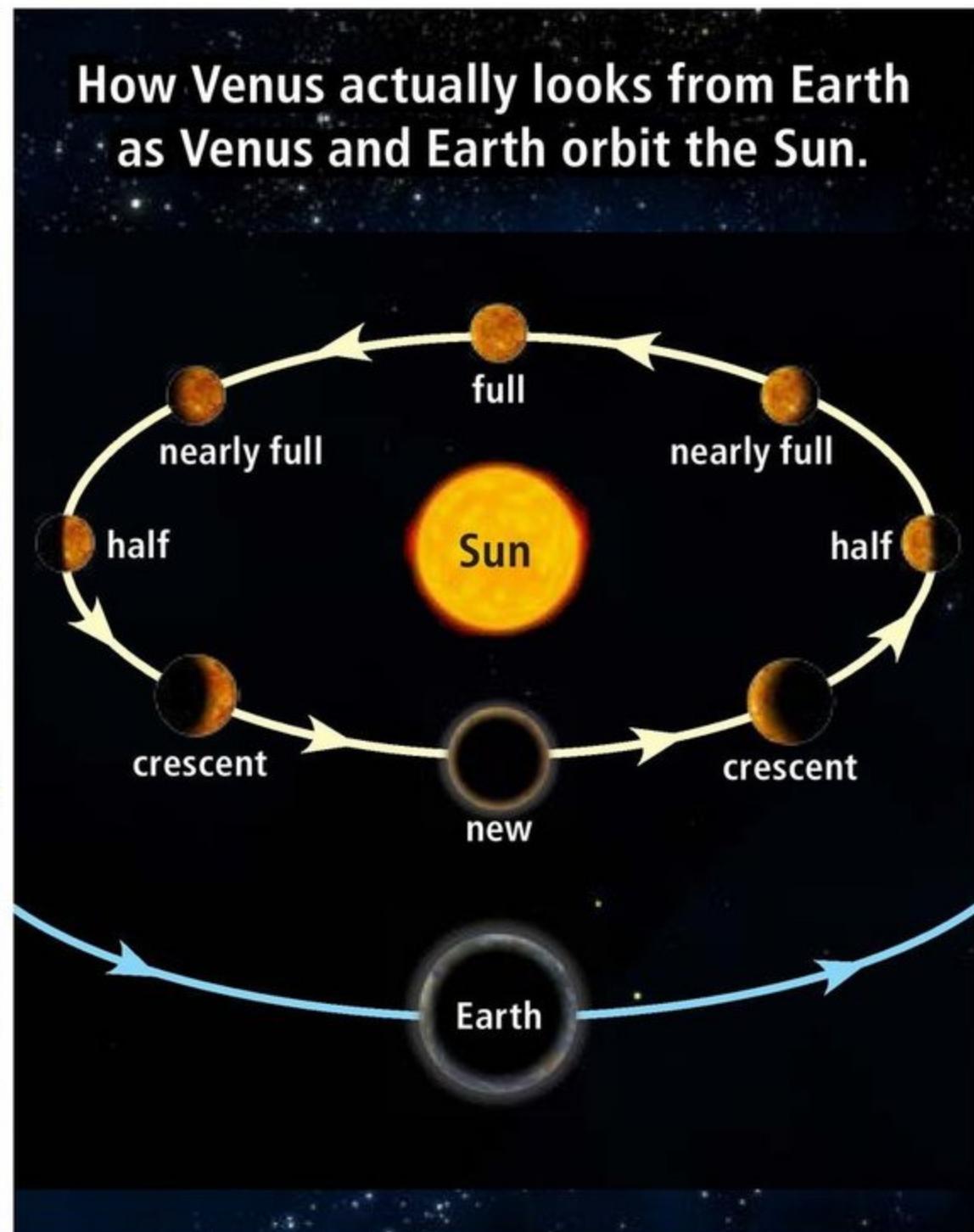
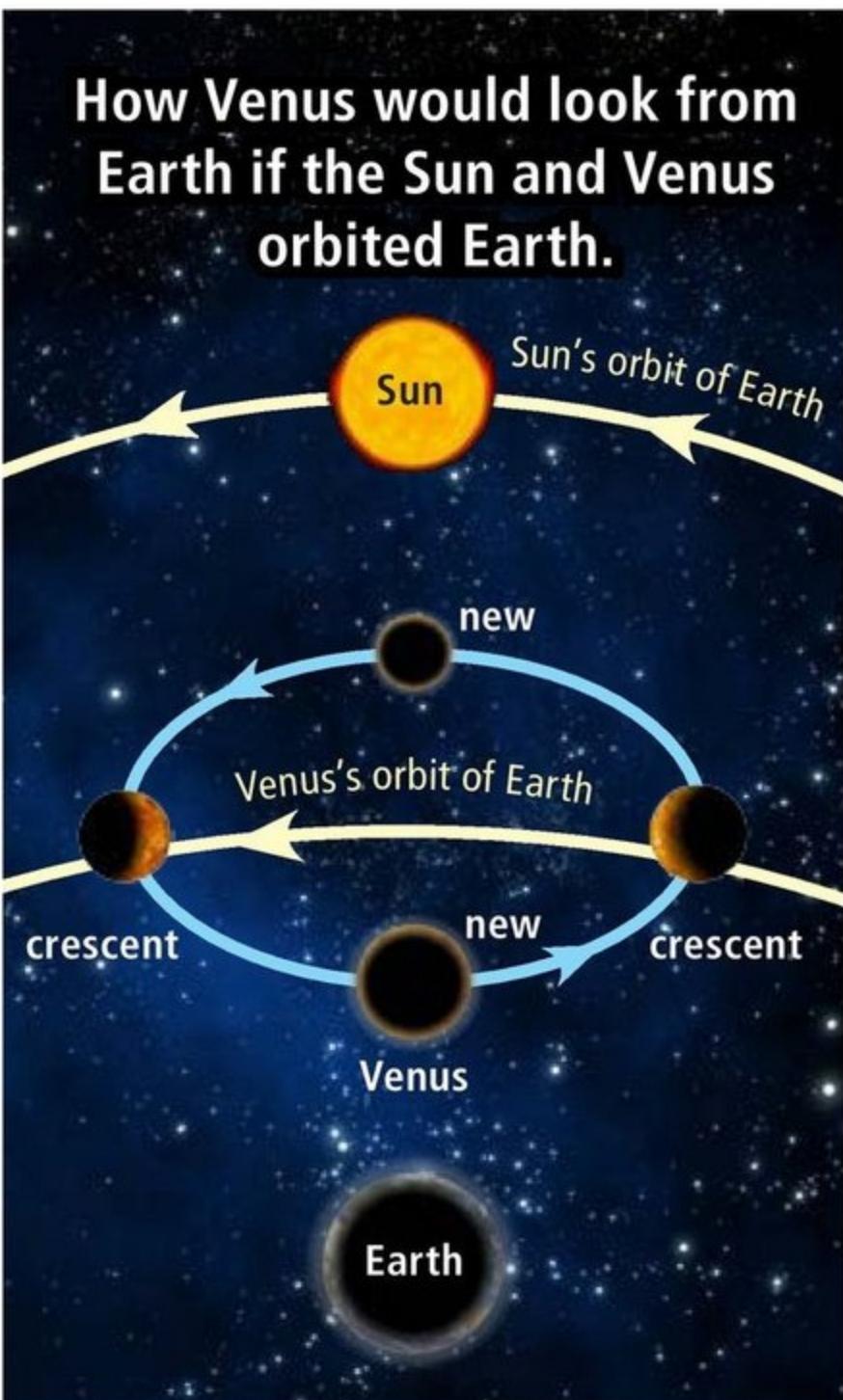
Galileo sketched the surface of the Moon (left) as he saw it through his telescope in 1610. NASA (the National Aeronautics and Space Administration) sent a probe named after Galileo to the Moon in 1992. The probe made a detailed scan of the Moon's surface (right) that clearly shows many of the same features Galileo noticed hundreds of years earlier.



## In Trouble with the Church

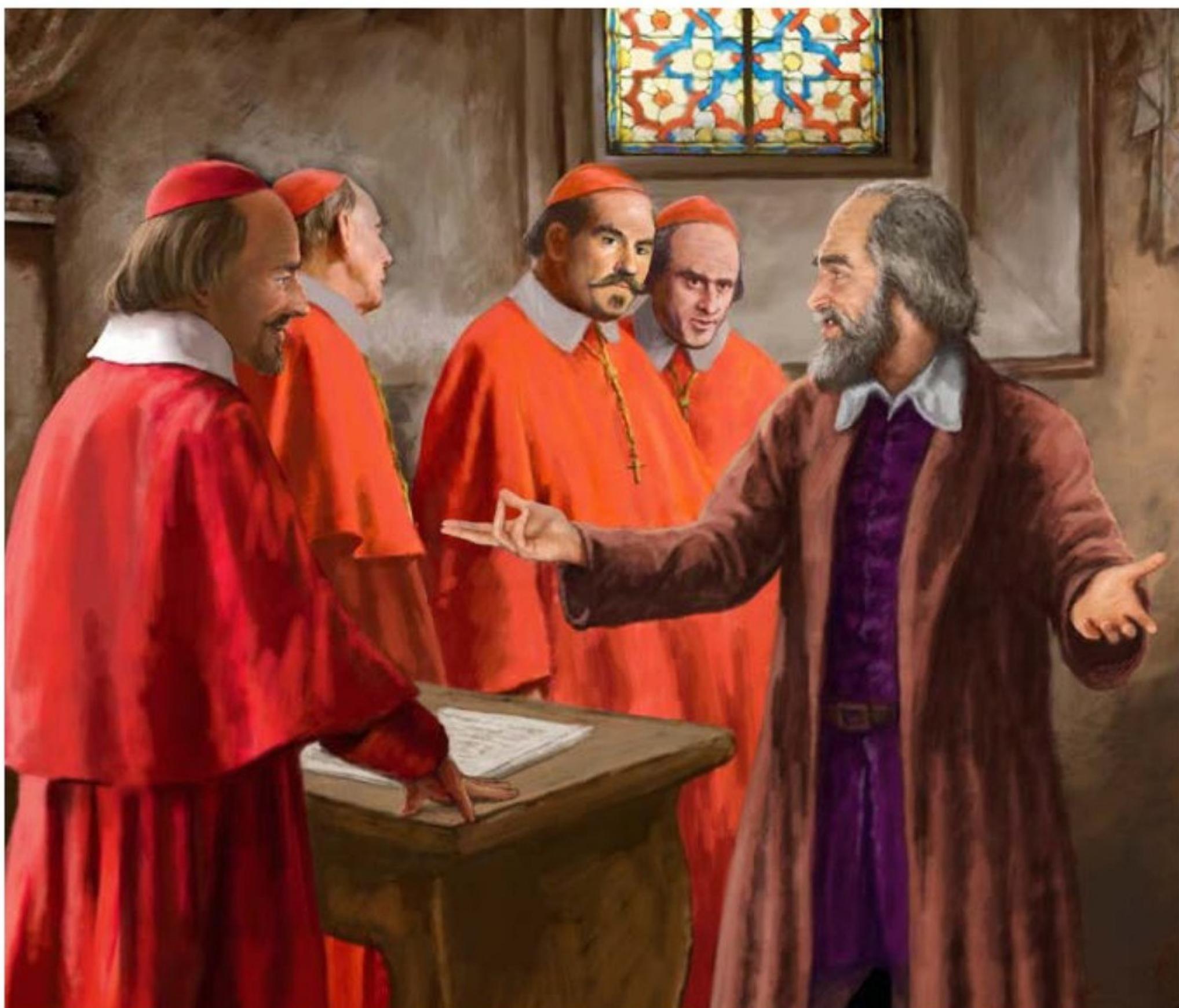
Galileo's discoveries about the solar system got him in a lot of trouble. In particular, the Catholic Church opposed his views. Why were sunspots and the phases of Venus so **controversial**?

The answer lies in the philosophy and religious beliefs of the time. For centuries, the Catholic Church had taught that the Sun, Moon, planets, and stars all revolved around Earth. According to this theory, heavenly bodies such as the Sun were perfect and unchanging. This theory, which placed Earth at the center of creation, originally came from the philosophers of ancient Greece. The Church officially adopted this theory long before Galileo's time.



But Galileo's discoveries showed that the Sun could and did change because of sunspots. The Moon was not "perfect" because it had craters. His discoveries also supported the idea that Earth was not the center of the solar system. Galileo showed that the changing way Venus appears from Earth would only make sense if Venus traveled around the Sun.

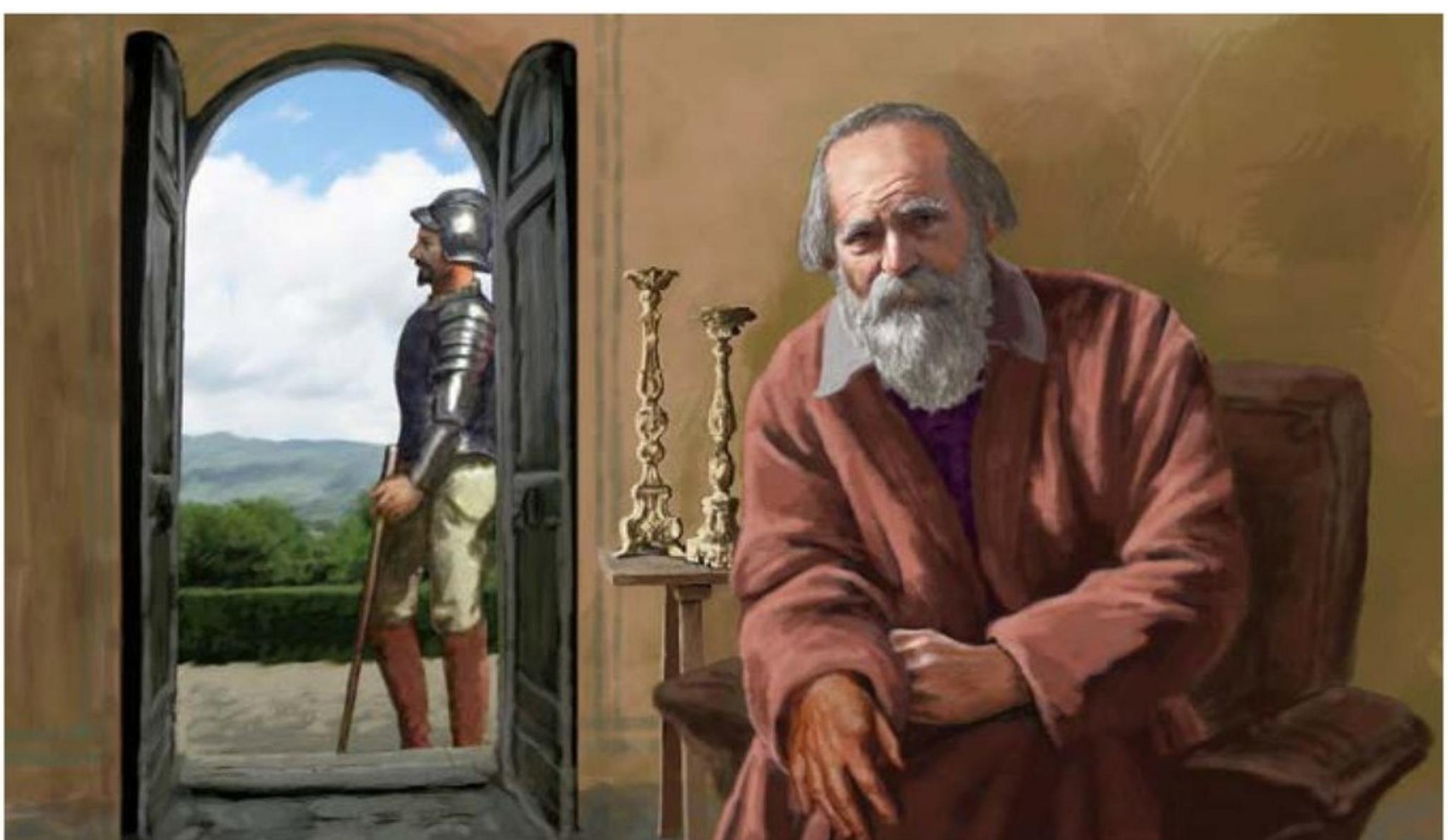
In other words, Galileo's discoveries were strong evidence that the planets in our solar system revolved around the Sun, not Earth. He was not the first person to come up with this theory. However, his discoveries were the best proof yet that Earth was not the center of our solar system.



Galileo published writings about his discoveries that angered the Church. During the Renaissance, the Church had the power to punish people who spread, or even had, ideas that challenged the Church's teachings. Galileo had committed **heresy** by insisting that the Church was wrong. In 1633, he was ordered to Rome to stand trial. At the trial, he was found guilty and threatened with death. Galileo was forced to say publicly that his earlier discoveries had been lies, even though they were accurate. He spent the rest of his life under house arrest, and he was also forbidden to publish.

## Do You Know?

In a popular, but unproven, story about this trial, Galileo was defiant until the end. The legend claims that Galileo murmured, "And yet it moves" under his breath after he was forced to say that Earth did not revolve around the Sun. This episode is not included in the records of the trial and is probably not factual. However, the phrase "and yet it moves" has become extremely famous; people quote it to this day.



Galileo continued to write about his discoveries after he was found guilty, however. He even managed to publish, despite being ordered not to do so by the Church. He published *Two New Sciences*, which summarizes some of his work, in 1638. It would be his final publication; at this point, Galileo had become blind.

Galileo's health continued to deteriorate, and he died in 1642 of natural causes.

## Science After Galileo

We now know that Galileo was right: Earth and the other planets in our solar system all revolve around the Sun. Galileo's habit of asking difficult questions led him to make some of the greatest discoveries of his age.

Scientists are still using many of Galileo's research methods. For example, he was the first to insist that laws of nature could be described using mathematical equations. This argument helped make science and mathematics separate fields of study, different from philosophy or religion. He was also one of the first scientists to insist on using **measurable** data in his experiments. By doing so, he made it easier for other scientists to test his theories. Scientists still use this principle today. Galileo had an enormous influence on scientists who followed him, including Isaac Newton and Albert Einstein. Today, we call him the father of modern science.

### Science and the Catholic Church

In 1757, the Catholic Church removed Galileo's book from a list of banned books. In 1992, the Church formally cleared Galileo of any wrongdoing. The modern Church accepts proven scientific facts and has supported scientific research for centuries.

## Glossary

<b>astronomy</b> ( <i>n.</i> )	a field of science involving the study of the stars, planets, comets, and other things found in space (p. 9)
<b>controversial</b> ( <i>adj.</i> )	causing much disagreement (p. 11)
<b>gravity</b> ( <i>n.</i> )	the natural force that tends to pull objects toward each other, such as objects being pulled toward the center of Earth (p. 8)
<b>heresy</b> ( <i>n.</i> )	a belief or practice that goes against the official teachings of an organized religion (p. 13)
<b>laws of nature</b> ( <i>n.</i> )	scientific truths or principles that explain how nature works (p. 6)
<b>measurable</b> ( <i>adj.</i> )	able to have a size or amount determined in measured units (p. 15)
<b>pendulum</b> ( <i>n.</i> )	a weight that hangs from a nonmoving point and swings from side to side (p. 7)
<b>philosophers</b> ( <i>n.</i> )	people who seek knowledge and truth about life; people who study philosophy (p. 4)
<b>revolutionary</b> ( <i>adj.</i> )	of or relating to the overthrow of previous ideas or ways of doing things (p. 5)
<b>solar system</b> ( <i>n.</i> )	a group of objects in space that orbit a star (p. 10)
<b>sunspots</b> ( <i>n.</i> )	dark patches that sometimes appear on the Sun's surface, caused by changes in the Sun's magnetic field (p. 10)
<b>telescope</b> ( <i>n.</i> )	an instrument used to make distant objects look closer (p. 9)

# Galileo

A Reading A-Z Level V Leveled Book  
Word Count: 1,328

## Connections

### Writing

Research to learn more about one of Galileo's discoveries. Write at least one paragraph describing the discovery and how it changed people's understanding of the world.

### Science

Draw a diagram or create a model of the solar system. Include details that Galileo discovered. Share your work with your class.



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