Galileo Galilei

***Excerpt from* The Starry Messenger (1610)**

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A scientific revolution occurred during the Renaissance through the influence of humanists who took a renewed interest in the work of ancient philosophers. Humanism was a movement initiated in Florence, Italy, in the mid-1300s by scholars who set out to revive the culture of ancient Greece and Rome (called the classical period). They hoped to start a cultural rebirth, or renaissance, that would end what they believed was the "barbarism" of the Middle Ages, the thousand-year period that began with the fall of the Roman Empire in the fourth and fifth centuries. Scientists were particularly interested in giving Greek texts updated translations and interpretations. They developed new theories that eventually replaced the Greek concepts that had dominated science for almost two thousand years. By the sixteenth century science had become a separate field from philosophy and technology, which had been the major areas of thought in ancient times. (Philosophy is devoted to a search for a general understanding of values and reality through speculative thinking. Technology is the application of practical knowledge, such as engineering.) An even more important development was that science now had a practical function. For instance, scientists

were asking *how* things happened in nature, whereas the ancients were mainly concerned with *why* things happened. This shift in thinking had a profound impact on all aspects of life, and by the end of the 1600s science had replaced Christianity (a religion founded by Jesus of Nazareth, called the Christ) as the center of European civilization.

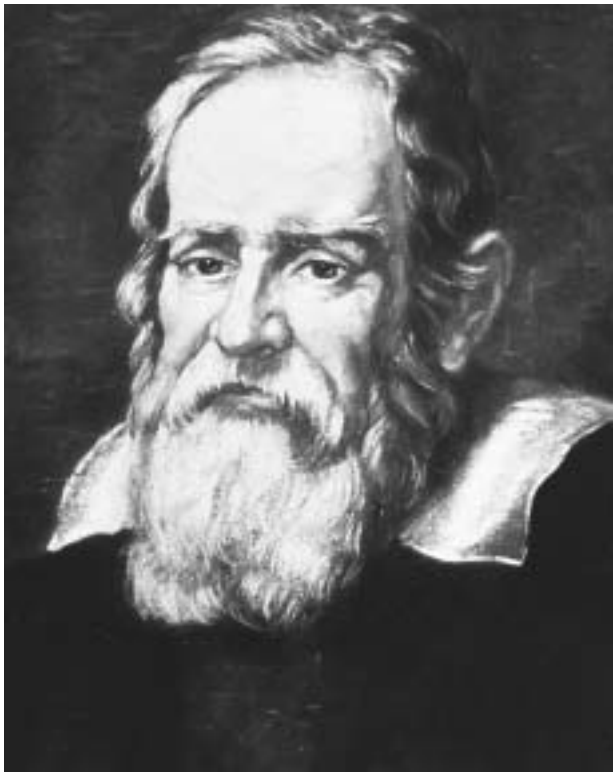
The most significant advances took place in the field of astronomy, the study of the number, size, and motions of heavenly bodies. At the beginning of the Renaissance astronomy was still linked with cosmology and astrology as it had been since ancient times. Cosmology is the study of the nature of the universe as an ordered structure, and it is closely allied with philosophy and theology (the study of religious faith, practice, and experience). Astrology is the "science" of the influences of heavenly bodies on earthly matters, including the lives and fortunes of humans. Some of the most famous Renaissance views of the universe, such as infinity (unlimited time and space), were developed not by astronomers but by philosophers and theologians (those who study religion). These ideas were then incorporated into astronomy. In fact, the scientific revolution began in astronomy, with the work of Polish astronomer Nicolaus Copernicus (1473–1543).

In 1543 Copernicus published *De revolutionibus orbium coelestium* (On the Revolution of the Heavenly Spheres), in which he gave proof that the Sun is the center of the universe. This idea was extremely controversial. At the time all astronomers accepted the theory of the ancient Egyptian scholar Ptolemy (Claudius Ptolemaeus; c. C.E. 100–c. 170), who stated that the Sun revolved around the Earth. Moreover, this view was enforced by the Roman Catholic Church, which found evidence for it in the Bible (the Christian holy book). Copernicus died only a few hours after *De revolutionibus orbium coelestium* was printed, however, and his work went virtually unnoticed for decades. Then in 1604 the Italian astronomer Galileo Galilei (called Galileo; 1564–1642) publicly declared that he supported Copernicus's theory of a Sun-centered universe.

A professor of physical sciences (study of the Earth and the universe) at the University of Padua in the Republic of Venice, Galileo had been attracting attention since he joined the faculty in 1592. At that time he gave three public

lectures before overflow audiences in Venice. He argued that a new star, which had appeared earlier that year, was major evidence in support of Copernicus's views. More important was a letter in which he stated his theory of natural motion. By natural motion Galileo meant that a body will fall freely in space, and he proposed the law of free fall to account for this phenomenon. This concept contradicted the accepted view that the universe was a perfectly ordered and fixed system in which no body can freely move on its own.

In 1609 Galileo learned about the success of some Dutch spectacle, or eyeglass, makers in combining lenses (pieces of glass that reflect images) into what later came to be called the telescope. He feverishly set to work, and on August 25 he presented to the Venetian Senate a telescope as his own invention. The success was tremendous. He obtained a lifelong contract at the University of Padua, but he also stirred up resentment when it was learned that he was not the original inventor. Within a few months, however, Galileo had made sensational discoveries, which he published on March 12, 1610, under the title *Sidereus nuncius* (The Starry Messenger). The booklet took the world of science by storm.



Italian astronomer Galileo began to gain public attention after asserting that he supported Nicolaus Copernicus's view of a Sun-centered universe.
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Things to Remember While Reading an Excerpt from *The Starry Messenger:*

- The telescope was a revolutionary scientific advancement. Prior to the development of telescopic lenses, astronomers had to rely on observations with the naked eye and on mathematical calculations when they studied stars and planets. Although some of their data were accurate, they could usually make only speculations because there was no way to have a close view of distant objects.

- In *The Starry Messenger* Galileo gave astonishing evidence about mountains on the Earth's Moon and about moons circling Jupiter. He also identified a large number of stars, especially in the belt of the Milky Way, a galaxy (very large group of stars), of which the Earth's solar system is a part.
- In the following excerpt from *The Starry Messenger* Galileo described how he made his telescope. He then detailed his observations of the surface of the Moon, which he found to be rough and uneven. This was an important discovery because astronomers at the time accepted the theory of the ancient Greek philosopher Aristotle (384–322 B.C.) that the surface of the Moon is perfectly smooth.

Excerpt from The Starry Messenger

About ten months ago a report reached my ears that a certain ***Fleming*** *had constructed a spyglass by means of which visible objects, though very distant from the eye of the observer, were distinctly seen as if nearby. Of this truly remarkable effect several experiences were related, to which some persons gave* ***credence*** *while others denied them. A few days later the report was confirmed to me in a letter from a noble Frenchman at Paris, Jacques Badovere, which caused me to apply myself wholeheartedly to inquire into the means by which I might arrive at the invention of a similar instrument. This I did shortly afterwards, my basis being the theory of* ***refraction.*** *First I prepared a tube of lead, at the ends of which I fitted two glass lenses, both* ***plane*** *on one side while on the other side one was* ***spherically convex*** *and the other* ***concave.*** *Then placing my eye near the concave lens I perceived objects satisfactorily large and near, for they appeared three times closer and nine times larger than when seen with the naked eye alone. Next I constructed another one, more accurate, which represented objects as enlarged more then sixty times. Finally, sparing neither labor nor expense, I succeeded in constructing for myself so excellent an instrument that objects seen by means of it appeared nearly one thousand times larger and over thirty times closer than when we regarded with our natural vision.*

It would be ***superfluous*** *to enumerate the number and importance of the advantages of such an instrument at sea as well as on*

Fleming: A Dutch lens maker.

Credence: Willingness to believe.

Refraction: Change in the direction of light.

Plane: Flat.

Spherically convex: Rounded, protruding shape.

Concave: Sunken.

Superfluous: Unnecessary.

land. But forsaking ***terrestrial*** *observations, I turned to celestial ones, and first I saw the moon from as near at hand as if it were scarcely two terrestrial* ***radii*** *away. After that I observed often with wondering delight both the planets and the fixed stars, and since I saw these latter to be very crowded, I began to seek (and eventually found) a method by which I might measure their distances apart.*

Now let us review the observations made during the past two months, once more inviting the attention of all who are eager for true philosophy to the first steps of such important contemplations. Let us speak first of that surface of the moon which faces us. For greater clarity I distinguished two parts of this surface, a lighter and a darker; the lighter part seems to surround and to ***pervade*** *the whole* ***hemisphere,*** *while the darker part discolors the moon's surface like a kind a cloud, and makes it appear covered with spots. Now those spots which are fairly dark and rather large are plain to everyone and have been seen throughout the ages; these I shall call the "large" or "ancient" spots, distinguishing them from others that are smaller in size but so numerous as to occur all over the* ***lunar surface,*** *and especially the lighter part. The latter spots had never been seen by anyone before me. From observations of these spots repeated many times I have been led to the opinion and conviction that the surface of the moon is not smooth, uniform, and precisely spherical as a great number of philosophers believe it (and the other heavenly bodies) to be, but is uneven, rough, and full of cavities and* ***prominences,*** *being not unlike the face of the earth, relieved by chains of mountains and deep valleys. The things I have seen by which I was enabled to draw this conclusion are as follows.*

On the fourth or fifth day after new moon, when the moon is seen with brilliant horns, the boundary which divides the dark part from the light does not extend uniformly in an oval line as would happen on a perfectly spherical solid, but traces out an uneven, rough, and very wavy line.... Indeed, many luminous ***excrescences*** *extend beyond the boundary into the darker portion, while on the other hand some dark patches invade the illuminated part. Moreover a great quantity of small blackish spots, entirely separated from the dark region, are scattered almost all over the area illuminated by the sun with the exception only of that part which is occupied by the large and ancient spots. Let us note, however, that the said small spots always agree in having their blackened parts directed toward the sun, while on the side opposite the sun they are crowned with bright contours, like shining summits. There is a similar sight on*

Terrestrial: Having to do with the surface of the Earth.

Radii: Plural of radius; line segments extending from the center of a circle.

Pervade: Spread over.

Hemisphere: Half of a sphere- or ball-shaped object.

Lunar surface: Surface of the Moon.

Prominences: Raised areas.

Excrescences: Projections.