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On the Shoulders of Giants: Isaac Newton and Modern Science

SHIRLEY GRIFFITH: This is Shirley Griffith.

STEVE EMBER: And this is Steve Ember with the VOA Special English program EXPLORATIONS. Today we tell about one of the world's greatest scientists, Isaac Newton.

SHIRLEY GRIFFITH: Much of today's science of physics is based on Newton's discovery of the three laws of motion and his theory of gravity. Newton also developed one of the most powerful tools of mathematics. It is the method we call calculus.

Late in his life, Newton said of his work: "If I saw further than other men, it was because I stood on the shoulders of giants. "

STEVE EMBER: One of those giants was the great Italian scientist, Galileo. Galileo died the same year Newton was born. Another of the giants was the Polish scientist Nicholas Copernicus. He lived a hundred years before Newton.

Copernicus had begun a scientific revolution. It led to a completely new understanding of how the universe worked. Galileo continued and expanded the work of Copernicus.

Isaac Newton built on the ideas of these two scientists and others. He found and proved the answers for which they searched.

SHIRLEY GRIFFITH: Isaac Newton was born in Woolsthorpe, England, on December twenty-fifth, sixteen forty-two.

He was born early. He was a small baby and very weak. No one expected him to survive. But he surprised everyone. He had one of the most powerful minds in history. And he lived until he was eighty-four.

Newton's father died before he was born. His mother married again a few years later. She left Isaac with his grandmother.

The boy was not a good student. Yet he liked to make things, such as kites and clocks and simple machines.

STEVE EMBER: Newton also enjoyed finding new ways to answer questions or solve problems. As a boy, for example, he decided to find a way to measure the speed of the wind.

On a windy day, he measured how far he could jump with the wind at his back. Then he measured how far he could jump with the wind in his face. From the difference between the two jumps, he made his own measure of the strength of the wind.

Strangely, Newton became a much better student after a boy kicked him in the stomach.

The boy was one of the best students in the school. Newton decided to get even by getting higher marks than the boy who kicked him. In a short time, Newton became the top student at the school.

SHIRLEY GRIFFITH: Newton left school to help on the family farm.

It soon became clear, however, that the boy was not a good farmer. He spent his time solving mathematical problems, instead of taking care of the crops. He spent hours visiting a bookstore in town, instead of selling his vegetables in the market.

An uncle decided that Newton would do better as a student than as a farmer. So he helped the young man enter Cambridge University to study mathematics.

Newton completed his university studies five years later, in sixteen sixty-five. He was twenty-two years old.

STEVE EMBER: At that time, a deadly plague was spreading across England. To escape the disease, Newton returned to the family farm. He did more thinking than farming. In doing so, he found the answers to some of the greatest mysteries of science.

Newton used his great skill in mathematics to form a better understanding of the world and the universe. He used methods he had learned as a boy in making things. He experimented. Then he studied the results and used what he had learned to design new experiments.

Newton's work led him to create a new method in mathematics for measuring areas curved in shape. He also used it to find how much material was contained in solid objects. The method he created became known as integral calculus.

SHIRLEY GRIFFITH: One day, sitting in the garden, Newton watched an apple fall from a tree. He began to wonder if the same force that pulled the apple down also kept the moon circling the Earth. Newton believed it was. And he believed it could be measured.

He called the force "gravity." He began to examine it carefully.

He decided that the strength of the force keeping a planet in orbit around the sun depended on two things. One was the amount of mass in the planet and the sun. The other was how far apart they were.

STEVE EMBER: Newton was able to find the exact relationship between distance and gravity. He multiplied the mass of one space object by the mass of the other. Then he divided that number by the square of their distance apart. The result was the strength of the gravity force that tied them to each other.

Newton proved his idea by measuring how much gravity force would be needed to keep the moon orbiting the Earth. Then he measured the mass of the Earth and the moon, and the distance between them. He found that his measurement of the gravity force produced was not the same as the force needed. But the numbers were close.

Newton did not tell anyone about his discovery. He put it aside to work on other ideas. Later, with correct measurements of the size of the Earth, he found that the numbers were exactly the same.

SHIRLEY GRIFFITH: Newton spent time studying light and colors. He used a three-sided piece of glass called a prism.

He sent a beam of sunlight through the prism. It fell on a white surface. The prism separated the beam of sunlight into the colors of a rainbow. Newton believed that all these colors -- mixed together in light -- produced the color white. He proved this by letting the beam of rainbow-colored light pass through another prism. This changed the colored light back to white light.

STEVE EMBER: Newton's study of light led him to learn why faraway objects seen through a telescope do not seem sharp and clear. The curved glass lenses at each end of the telescope acted like prisms. They produced a circle of colored light around an object. This created an unclear picture.

A few years later, Newton built a different kind of telescope. It used a curved mirror to make faraway objects seem larger.

Light reflected from the surface of the mirror, instead of passing through a

curved glass lens. Newton's reflecting telescope produced much clearer pictures than the old kind of telescope.

SHIRLEY GRIFFITH: Years later, the British astronomer Edmund Halley visited Newton. He said he wanted Newton's help in finding an answer to a problem no one had been able to solve. The question was this: What is the path of a planet going around the sun?

Newton immediately gave Halley the answer: an egg-shaped path called an ellipse.

Halley was surprised. He asked for Newton's proof. Newton no longer had the papers from his earlier work. He was able to recreate them, however. He showed them to Halley. He also showed Halley all his other scientific work.

STEVE EMBER: Halley said Newton's scientific discoveries were the greatest ever made. He urged Newton to share them with the world.

Newton began to write a book that explained what he had done. It was published in sixteen eighty-seven. Newton called his book “The Mathematical Principles of Natural Philosophy.” The book is considered the greatest scientific work ever written.

SHIRLEY GRIFFITH: In his book, Newton explains the three natural laws of motion. The first law is that an object not moving remains still. And one that is moving continues to move at an unchanging speed, so long as no outside force influences it.

Objects in space continue to move, because nothing exists in space to stop them.

Newton's second law of motion describes force. It says force equals the mass of an object, multiplied by the change in speed it produces in an object.

His third law says that for every action, there is an equal and opposite reaction.

STEVE EMBER: From these three laws, Newton was able to show how the universe worked. He proved it with easily understood mathematics. Scientists everywhere accepted Newton's ideas.

The leading English poet of Newton's time, Alexander Pope, honored the scientist with these words: "Nature and Nature's laws lay hid in night. / God said, 'Let Newton be!' and all was light."

SHIRLEY GRIFFITH: This Special English program was written by Marilyn Christiano and Frank Beardsley. This is Shirley Griffith.

STEVE EMBER: And this is Steve Ember. Listen again next week for another Explorations program on the Voice of America.