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Galileo's Discoveries, 400 Years Later, Still Open Eyes

Astronomer's Telescope, on View Outside Italy for the First Time, Helped Expand Perceptions of the Universe

PHILADELPHIA—In the hands of Galileo, the telescope now on display at the Franklin Institute here was an instrument of revolution. Stained with use like a worn pick handle, this tool moved the planets, overturned empires of faith and forever altered our sense of place in the cosmos.

Four centuries after the Italian astronomer first turned his spyglass skyward, astronomy is honoring its origins in this deceptively simple instrument, with an International Year of Astronomy celebrated in 137 countries. Through his arrangement of

SCIENCE JOURNAL



By Robert Lee Hotz

lenses—the optical tube still bears assembly notes in his cursive scrawl—Galileo melded technology to his sense of sight, beginning a process that progressively expanded our perceptions of the universe in ways that continue to challenge us intellectually and spiritually. “The universe got bigger and bigger until it is beyond our comprehension,” says Marcia Bartusiak, author of a new history of modern cosmology called “The Day We Found the Universe.”

While curators prepared the vintage telescope for its journey to Philadelphia—the first time it has ever been shown outside Italy—NASA last month successfully launched its \$591 million Kepler orbital observatory to search for habitable planets around other stars. Next month, the European Space Agency plans to launch its \$2 billion Herschel and Planck orbital observatories, which will probe our universe in spectral ranges beyond the capacity of the naked eye, seeking celestial echoes from the beginning of time and space.

“All of the astronomical research we are doing today—observing quasars at great distances, discovering black holes

at the center of super-massive galaxies, finding planets orbiting other stars, being able to catalogue the number of stars in the sky—all of these are descendants of Galileo's work,” says Derrick Pitts, the Franklin Institute's chief astronomer.

As a priceless artifact, the telescope is the centerpiece of an exhibit of 100 scientific instruments of the Italian Renaissance drawn from the collection of Istituto e Museo della Storia di Scienza in Florence and funded by Italian watchmaker Officine Panerai. Measurement, as the Franklin exhibition emphasizes, is the essence of science. Displays of lavishly decorated spiral thermometers, brass astrolabes, elaborate armillary spheres and theodolites—even Michelangelo's compass kit—testify to the era's appetite for precise technical information.

Inspired by the anniversary of Galileo's discoveries, astronomers are working to make a million inexpensive but high-quality copies of his telescope available world-wide, so that students and others can make for themselves the observations that so changed our world. “We saw this as an opportunity to connect people with the universe,” says astronomer Lars Lindberg Christensen at the European Southern Observatory in Munich.

To match Galileo's original innovation, a team of 15 U.S. astronomers and optical engineers labored for two years to design a cheap, high-quality telescope kit. “We took as our challenge to design an inexpensive telescope that could see the rings of Saturn”—one of Galileo's first and most perplexing observations—says astronomer Stephen Pompea at the National Optical Astronomy Observatory in Tucson, Ariz., who led the design group.

Their “Galileoscope” features optics sharp enough to work well even under the glare of urban streetlights; yet is easy for anyone to quickly assemble and use. They crafted it with a child's eye in mind. “We want children to actually experience



Curators last week arranged Galileo's 400-year-old telescope for display at the Franklin Institute in Philadelphia. At right, a 19th century artist imagined how the Italian astronomer first shared his revolutionary view of the moons of Jupiter with members of the Venetian Senate.

Galileo's observations,” says Kaz Sekiguchi at the National Astronomical Observatory of Japan in Tokyo. “They can have their own feelings for the universe. They can appreciate the beauty of the sky.”

To be sure, Galileo did not invent the telescope. It was a toy in the Venice of his day.

No one can determine who actually deserves the credit. This much is certain, records Harvard University science historian Owen Gingerich: When a Dutch spectacle maker named Hans Lipperhey tried to patent his version of a viewing tube in 1608, the authorities of the States General of Holland rejected the claim because the device was already so well-known. Galileo, however, transformed it into a precision optical instrument that could clearly magnify objects up to 30 times their normal size.

Galileo may not have even been the first to use it as an astronomer.

An English mathematician named Thomas Harriot used a “Dutch truncke”—as a telescope was then called—to map the

moon's craters nearly four months before Galileo made his own first lunar observations public, Oxford University historian Allan Chapman reported earlier this year in the Royal Astronomical Society's journal *Astronomy & Geophysics*.

Unlike Galileo, however, Mr. Harriot saw no need to publish his drawings and they had no influence on the progress of science. More than a dozen of his pen and ink lunar drawings do survive, and his first moon map—dated 26 July 1609—will be displayed in Florence this summer as part of an exhibition on Galileo. A selection of his other images will be shown in July at London's Science Museum.

A mathematician and experimental physicist, Galileo, however, immediately recognized that what he could see of Venus, Jupiter and the moon through his telescope offered crucial evidence that the sun, not Earth, was the center of our solar system. The evidence of his eyes overturned 2,000 years of accepted wisdom about cosmology in which philosophers had con-

ceived the night sky as a system of crystalline spheres.

Moreover, Galileo quickly shared his observations with scientists throughout Europe by openly publishing his data.

“He wrought a change so fundamental for science and for humanity,” says Munich astronomer Pedro Russo, who is global coordinator of the International Year of Astronomy. “For the first time, we realized we were not the center of the universe.”

But his insistence on contradicting traditional cosmology led to his arrest and trial by the Roman Catholic Church. He was forced to recant his views and imprisoned for life. The Vatican did not formally admit that Galileo was correct until 1992. Now Vatican authorities are planning a statue in his honor.

During his life, Galileo is known to have built at least 100 telescopes, mostly as ornate presentation gifts for his patrons—the powerful Medici family of Florence. Only one is known to survive with its optics intact—the humble device now on show at the Franklin Institute.

“We assume it was personally used by Galileo,” says Paolo Galluzzi, director of the science museum in Florence, which

loaned the telescope for the exhibit. “Only this one was found among his property at his death. We believe that this is one of the major tools of his work.”

Next month, astronomers at the Galileoscope project expect to begin distributing their kit world-wide. By offering a small personal window on the universe, they hope the telescope will help students better understand the nature of research.

“Science is fundamentally about establishing truth for yourself,” says Dr. Pompea in Arizona. “People can make observations, take data and establish for themselves the nature of the universe. They don't have to take it from someone else or read it in a book.”

Like Galileo, “they can see it.”

Robert Lee Hotz also shares recommended reading on this topic and responds to reader comments at WSJ.com/Currents. Email him at sciencejournal@wsj.com.

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ONLINE TODAY: See the vintage Galileo telescope on display at Philadelphia's Franklin Institute at WSJ.com/Video.



Reuters (left); Everett Collection (right)