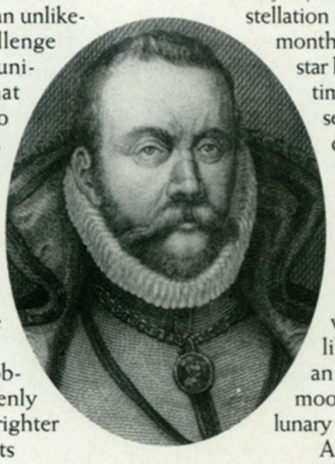
Danish astronomer argues for a changing cosmos

HVEN, Denmark, January 1578 — Heavens! Could the teachings of Aristotle and other scholars all be wrong?

This placid island seems an unlikely place from which to challenge the prevailing view of the universe. But that's just what Danish astronomer Tycho Brahe has done. Two of his recent discoveries promise to shatter centuries of learned pronouncements that the cosmos is eternal and immutable. The findings suggest instead that chaos, turmoil, and change rule the universe.



Tycho Brahe is famous for his precise measurements.

Just 6 years ago, Tycho observed that stars can suddenly appear in the sky, blazing brighter than the planet Venus at its most luminous, and then fade from view. Now, he declares that the fuzzy, highly unstable objects known as comets reside in a region far beyond the moon, a region of the heavens thought to be unwavering and immutable.

The findings have all of Europe agog.

Tycho's odyssey began on the evening of Nov. 11, 1572. Walking back to his alchemy laboratory at Herrevad Abbey, near Copenhagen, the 26-year-old astronomer saw a brilliant white object that outshone Venus. Several of his servants and peasants confirmed his observations, he reported at the time.

The object, slightly northwest of the constellation Cassiopeia, remained for 18 months in a patch of sky where no star had ever been seen before. At times, it was so bright that observers could view it in broad daylight. It also changed from white to red to leaden gray.

Tycho and other astronomers scrambled to determine whether the new object moved across the sky. Any discernible motion would indicate the point-like object was not a star but an object nearer than the moon, within the so-called sublunary sphere. If so, the theories of Aristotle, Plato, and others who extoll the purity of the heavens could still hold.

The young astronomer had just built a new version of a sextant, a compass-shaped device that accurately measures the latitude and longitude of distant objects. Tycho's sextant, which features 5.5-feet-long arms joined by a brass hinge, is unsurpassed in detecting the subtle movement of distant objects, he says. When he applied the device to the bright apparition, he reports in his book *De Stella Nova*, it stood stock-still and so must be a star.

The startling discovery so intrigued King Frederick of Denmark that he bequeathed this island to Tycho for a new observatory. Still, the astronomer's finding cannot alone refute centuries of scholarly thought. A new study reported by Tycho just a few days ago, however, could force scientists to revise their long-held beliefs.

The newest drama began last November while Tycho was catching fish at dusk in one of his island's many ponds. He noticed what appeared to be a bright star in the western sky. As the evening grew darker, however, he saw that the object had a reddish tail, the telltale signature of a comet.

After sketching the comet, Tycho recorded its distance from two nearby stars in order to determine its position. Over the next few weeks, he diligently tracked the fading comet's motion and found that it has no measurable parallax—the extra motion of nearby objects due to Earth's movement through the heavens.

Indeed, in a report to the king, Tycho calculates that the comet must lie farther away than 230 times the radius of Earth, or more than four times the distance to the moon. There can be no doubt that the comet is a bona fide celestial body, beyond the sublunary sphere, and thus in direct conflict with the teachings of the ancients, Tycho says.

The king and others seem swayed by Tycho's careful measurements. Whether this comet of 1577 turns out to be an evil omen or a harbinger of good tidings remains to be seen, but it may spark a revolution in the way people view the cosmos. —*R. Cowen*

Weights make haste: Lighter linger

PISA, Italy, December 1612—In a new test of an old idea about motion, philosophers recently dropped objects from the cathedral bell tower, which tilts because of a construction flaw. The experimenters observed that large, heavy bodies fall faster than small, light ones of the same material—a behavior of matter described long ago by Aristotle but often disputed in recent decades.

Not only did the investigators witness a difference in speed, but they also noted that "in proportion as the weight increases, so does the velocity," says Giorgio Coresio, professor of Greek at the University of Pisa, who led the study.

"Thus was confirmed the statement of Aristotle, in the first book of *De Caelo*, that 'a mass of gold or lead, or of any other body endowed with weight is quicker in proportion to its size,'" Coresio concludes. He describes the experiment in a new book *Operetta intorno al Galleggiare de Corpi Solidi*.

Skeptics of Aristotle's statement say that they remain unconvinced, however. Such a test of the ancient assertion is so dramatic "that I meant to do it myself, but I don't recall if I ever got around to it," comments Galileo Galilei, philosopher and mathematician to the Grand Duke of Tuscany.

He contends that even casual observations negate Aristotle's law and Coresio's assertions. "If two stones were flung at the same moment from a high tower, one stone twice the size of the other, who would believe that when the smaller was half-way down the larger had already reached the ground?" he asks.

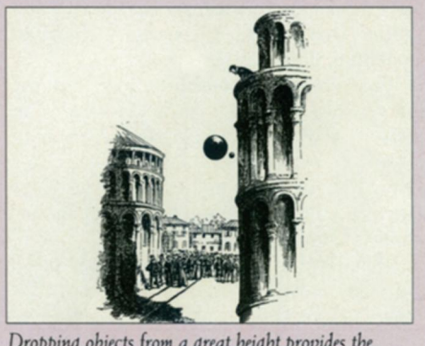
Galileo adds, "How ridiculous is this opinion of Aristotle is clearer than light" when one thinks it through, applying Archimedes' notions regarding the buoyancy of bodies in a medium.

He notes that other philosophers have carried out experiments similar to that of Coresio and his colleagues but have refuted Aristotle. Fifteen years ago, Jacopo Mazzoni, also of the University of Pisa, reported that he had observed objects falling at the same speed regardless of weight (SN: 5/15/1597, p. 310) and pieces of an object descending at the same rate as the whole.

On the other hand, it has proved difficult to demonstrate that bodies of different weights fall at exactly the same rate, Galileo concedes. For instance, experiments in which he has rolled balls down inclined planes have not yielded clear-cut evidence.

Regarding Mazzoni's experiment, Coresio replies, "Perhaps he made his experiment from his window, and because the window was low, all his heavy substances went down evenly. But we did it from the top of the cathedral tower." The 190-foot-tall tower provides an unusually well-placed perch from which to launch long descents.

A 30-foot drop would surely be enough to show the difference if Aristotle's proposition were true, contends Simon Stevin, engineer to Prince Maurice of Nassau. He and a fellow experimenter reported in 1586 that they had dropped two lead balls, one 10 times the other in weight, from such a height onto a plank. They heard "the sound of the two striking ... as one single report," he says (SN: 11/7/1605, p. 293). What's more, the same also held true for balls of different materials, he notes. —*P. Weiss*



Dropping objects from a great height provides the latest test of controversial laws of falling bodies.