Leon Foucault and The Turning Earth

IN 1851, we first knew for certain something which had been long suspected. The Earth does not stand still at the centre of the cosmos, as the ancients had believed, but turns on its axis once every 24 hours, so giving the appearance of a daily motion to the heavens and all that they hold.

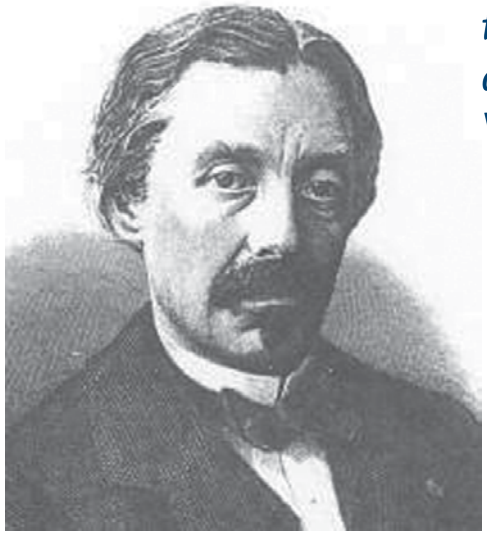
A turning Earth had been used to explain some well observed phenomena, such as the tendency of large systems of wind to blow into circles (by the Frenchman Gustav Coriolis) and the bulge of the Earth at the equator (by the Englishman Isaac Newton). Yet strictly speaking, they were not evidence for a turning Earth. There could have been other explanations.

Galileo had gone before the Inquisition in 1633 believing that the Earth moved, not only on its axis, but also in a yearly journey around the Sun. But he really had no evidence. He argued that the tides in the oceans might be due to the shaking of the Earth as it spun, like water splashing in a shaken bowl, but that was not very convincing.

More than 300 years after Galileo, the Frenchman Leon Foucault did provide evidence, an observation that allowed only one explanation. According to his journal, he first achieved his goal in the small hours of January 6, 1851, working in the basement of the house he shared with his mother.

In an experiment he was later to repeat on a much grander scale, he hung a small brass bob on a wire 2 metres long from the ceiling of the basement, and set it swinging freely. As he had anticipated, the pendulum did not remain swinging back and forth in the same direction, as Newton's First Law of Motion would require. Over several hours, the plane of its motion slowly turned. It was a momentous observation.

Foucault explained what he saw by assuming the bob did keep swinging in the same plane, as Newton demanded, but that his basement, fixed to the Earth, slowly turned beneath the bob as it moved in space. This caused the pendulum to appear to defy Newton. Put another way, he showed that the surface of the Earth, and anything on it, is not an "inertial frame of reference", and therefore the Earth must be turning.



Leon Foucault (1819 – 1868) demonstrated that the Earth did indeed rotate.

Over coming months, Foucault repeated his observations in public, using heavier bobs, so the motion was less easily upset, and longer wires, so the pendulum swung more slowly. The first of those was in the Paris Observatory in February of that year.

His most famous demonstration, and the one that made his public reputation, took place under the vast dome of the Pantheon in Paris. There on March 31, 1851, a crowd which included the French Emperor Napoleon III, saw a 30 kilogram iron ball swing backwards and forwards at the end of a 70 metre chain. It's impressively grand motion was made to trace a line in sand on the floor. Again, over some hours, the direction of the line in the sand slowly changed. The Earth does turn. It was undeniable.

Behind the phenomena of the pendulum lies a profound question, still unanswered. Why?

There is more to Foucault's insight. He realised that the rate at which the plane of the pendulum turned would not be the same everywhere. At the Earth's north and south poles, the pendulum's movement would encompass a whole circle every 24 hours, whereas at the equator it would not change at all. In latitudes between, the rate of turn would obey a simple formula, soon proved correct as Foucault pendulums were set up in many places.

Behind the phenomena of the pendulum lies a profound question, still unanswered. Why? In its motion, controlled by inertia, the pendulum keeps moving in a direction determined not by the influence of the nearby massive Earth, as would be the case if the bob was let fall, but toward a fixed point in the distant universe, out among the stars and galaxies. Does this mean the origin of the inertia, which causes the pendulum to continue to plough the same furrow in space, lies out there as well?

That at least was the conclusion reached by the German Ernst Mach, as he pondered the mystery of the pendulum. Does the pendulum bob, and any other object, have inertia because of the presence of the rest of the universe. To say yes to that is to agree with the *Mach Principle*. If the rest of the universe suddenly vanished, would inertia likewise disappear? The experiment can never be done but the question remains. ✦

***David Ellyard** presented SkyWatch on ABC TV in the 1980s. His StarWatch StarWheel has sold over 100,000 copies.*