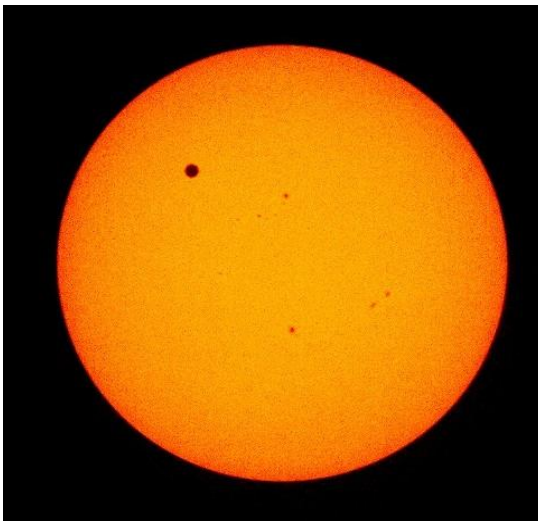
Francis Wollaston and the Transit of Venus

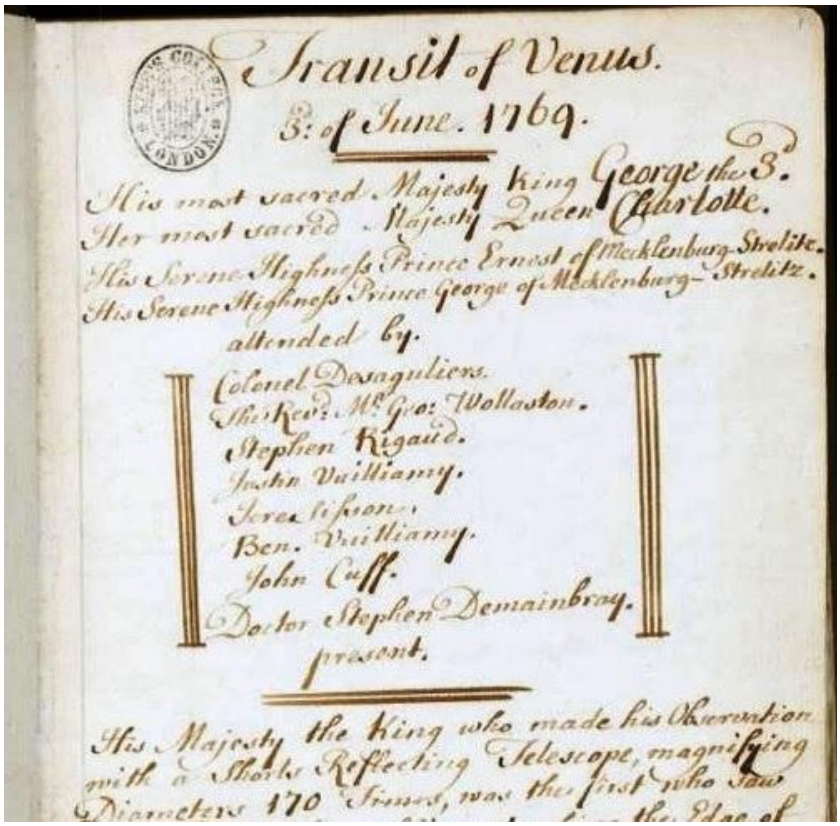
Trevor Ogden

Measuring the Solar System



The planet Venus passing across the Sun's disc during the 2012 Transit, viewed from the International Space Station (NASA)

It was June 3rd, 1769. In the stockade his crew had built on the Pacific Island of Tahiti, Captain James Cook looked up in satisfaction at the bright morning sky. Later, he wrote in his journal, "This day prov'd as favourable to our purpose as we could wish, not a Clowd was to be seen the whole day and the Air was perfectly clear". In Pondicherry, India, Guillaume Le Gentil looked up gloomily at the clouds. It was more hopeful for other observers in the Spanish territory of California, and at the Prince of Wales Fort on Hudson's Bay. In the Old Deer Park, at Richmond, Surrey, the weather also looked good. It was a summer evening, and King George III sat in the observatory built specially for this occasion. One of the gentlemen with him was George Wollaston, FRS, Mathematical Lecturer at Sidney Sussex College, Cambridge University, who was something of an expert on celestial mechanics


Transit of Venus.
3: of June. 1769.
His most sacred Majesty King George the 3.
Her most sacred Majesty Queen Charlotte.
His Serene Highness Prince Ernest of Mecklenburg-Strelitz.
His Serene Highness Prince George of Mecklenburg-Strelitz.
attended by.
Colonel Desaguliers.
The Revd. Mr. Geo: Wollaston.
Stephen Rigaud.
Justin Vuilliamy.
Jere. Sisson.
Ben. Vuilliamy.
John Cuff.
Doctor Stephen Demainbray.
present.
His Majesty the King who made his Observation
with a Shorts Reflecting Telescope, magnifying
Diameters 170 Times, was the first who saw

Notes of the King's observations of the 1769 Transit. George Wollaston is second on the list of those attending.

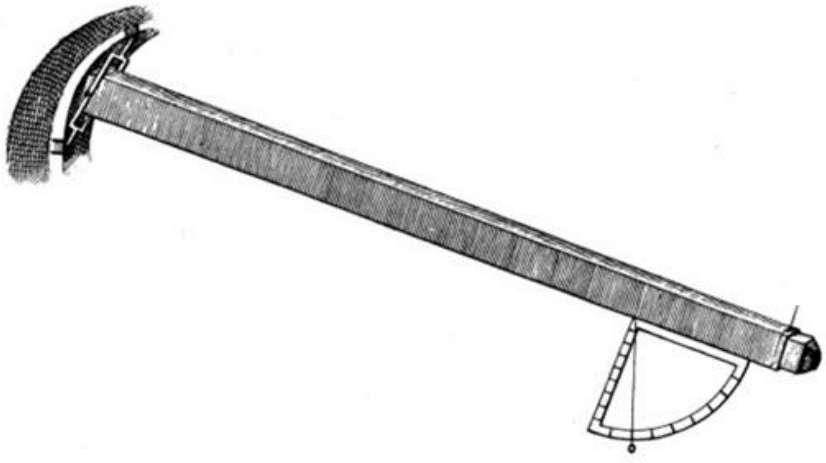
And in the vicarage of East Dereham, Norfolk, sat the rector, George's older brother, Francis Wollaston. He had made his own preparations, and was now watching the Sun through his heavily smoked glass and his telescope, until he saw the small black disc of the planet Venus just touch the edge of the sun and begin its slow journey across the bright face, a journey known as the Transit. As he later wrote to the Royal Society to report his measurement,

" In watching for the first contact of Venus, I kept my eye on the Sun's edge where the contact was expected; keeping that point nearly in the center of my field, and

the first impression which I saw was at 7hr, 12 minutes, 39 seconds mean solar time."
In Richmond, the King saw the disc touch the sun 18 seconds later. Unfortunately, it clouded over soon after, and both in Dereham and Richmond the sun had set before the transit was complete.

This clock, made by John Holmes in about 1775, is like the one used by Francis Wollaston for timing the Transit. This one was sold by Christies in 2008 for £22,000

Francis was 38. He had first been trained in the law, and had then been ordained, but he seems to have had a stronger interest in astronomy. He became a Fellow of the Royal Society in 1769, the year of the Transit, and showed the same practical skill and gift for experimental observation for which his son William Hyde Wollaston later became famous. He securely mounted his telescope in a window of the Dereham rectory, and apparently had a distant mark by which he could accurately tell the direction of south. Later, when he had moved to Chislehurst, he described his observatory there to the Royal Society. His telescope was "fastened to a large stone pillar, bedded on the wall of the house", with the due south direction indicated by "a mark 700 feet distant". Perhaps he had a similar arrangement at Dereham, with his telescope mounted



The telescope mounting that Francis used in 1769. The left-had end would have been secured in his window, pivoted so that it could be moved from side to side and up and down

so that he could tell accurately in which direction and at what upward angle it was directed.

To make his observations, Francis also needed a good clock. He bought one from the distinguished clock-maker John Holmes, of London. It had a wooden pendulum with a large bob, with as smaller bob underneath for fine adjustment of the speed of the clock, which was firmly fixed to the chimneybreast. Francis demonstrated his rare skill by observing known stars passing the north-south line with his telescope, and adjusting his clock so he knew solar time to within a second.

Point Venus, Tahiti, where Captain Cook made his observations

What was it all for? By the 1700s, the careful observations by earlier astronomers meant that the structure of the solar system was well understood. However, although the relative distances of the planets were known, for example that Venus was only 0.723 times as far from the Sun as the Earth, no one knew whether the Earth was 50 million miles from the Sun, or 100 million, or 150 million. If this distance could be measured, then all the other distances in the Solar System could be calculated. In 1663, James Gregory, a Scottish astronomer and mathematician, described how the distance to the Sun could be calculated if observers timed a Transit of Venus from different parts of the world whose latitudes and longitudes were accurately known; some ingenious trigonometry could then be applied to calculate the distance from the times.

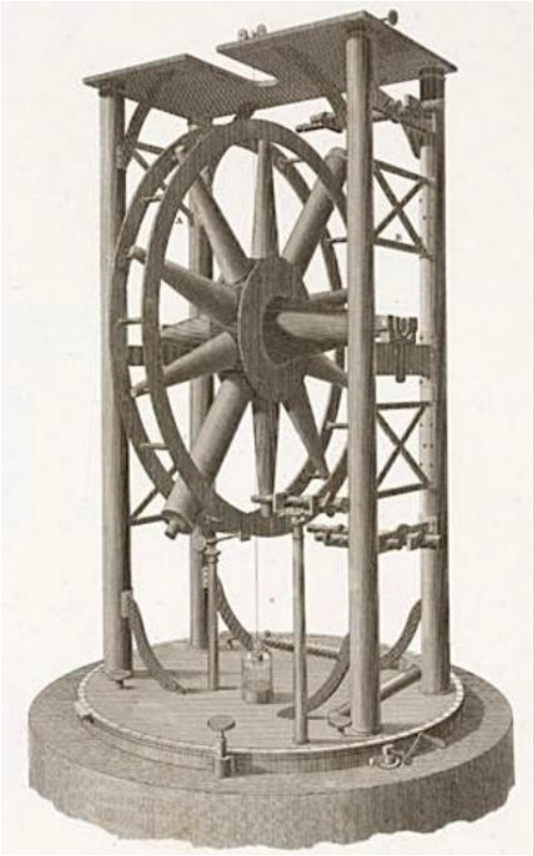
Transits occur because Venus orbits the Sun inside the Earth's orbit, so every now and then the planets exactly line up, so Venus appears to pass across the Sun's face. The exact motion is complicated, however, and usually the planets pass without being exactly lined up. The Transits, with the planets lined up with the Sun, come in pairs, with the second coming 8 years after the first, and then a gap of over 100 years before the next pair. The first pair after James Gregory's prediction was in 1761 and 1769.

There were some unsuccessful attempts to make the necessary observations in 1761, but for the 1769 Transit, as we have seen, things were better organized. Captain Cook arrived home In July 1771, and delivered his timings to the Royal Society. The ones from the other stations had apparently already arrived, and in December Thomas Hornsby, Professor of Astronomy at Oxford, read a paper to the Society in which he used the results to calculate the distance to the Sun, which he made 93,726,000 miles. The distance varies with the time of year, but this is within 1% of the mean value determined by radar, so in those terms the exercise was a great success. Hornsby only used the measurements from sites which could record both the start and the finish of the Transit.

What happened to everyone?

After he moved to Chislehurst later in 1769, Francis improved his equipment and carried out many years of careful astronomical work, presenting many papers to the Royal Society, and publishing a general catalogue of stars, that is a list of the prominent visible stars with accurate measurements of their positions. This sounds dull, but was fundamental in identifying changes and minute stellar movements. In 1781 his friend William Herschel noticed a "star" that moved, against the well-catalogued background of fixed stars, and this turned out to be a newly-discovered planet, Uranus.

But there does not seem to be a record of whether or not Francis as a clergyman was a good shepherd to his flocks in either Dereham or Chislehurst.



The improved mounting which Francis designed at Chislehurst, which allowed accurate positioning of the telescope in any directions. (Sue Walker)

Allthough Francis moved his instruments, the most important thing that he took to Chislehurst from the point of view of science was his 3-year-old son, William Hyde Wollaston, who 50 years later was famous throughout Europe for his discoveries, and turned out to be probably the most significant person ever born in Dereham.

Francis' brother George, who had been honoured to be present at the King's observations because of his early work on celestial mechanics, does not seem to have done anything else very noteworthy, although he lived until 1826. He also was a clergyman, and was a Doctor of Divinity as well as a Fellow of the Royal Society.

While Captain Cook's crew carefully packed his instruments, he unsealed his further orders, and found he was to explore the South Pacific. He mapped New Zealand and the east coast of Australia on the way home, claiming eastern Australia for Britain, but without consulting the people already living there.

The unhappiest story is that of Guillaume le Gentil, the French astronomer observing the Transit in Pondicherry. He had left Paris in March 1760, planning to observe the 1761Transit, but his ships were delayed by war and bad weather, and he did not get to India until after the event. In view of the difficulties, he decided to wait in Pondicherry for the 1769 Transit, as there would then be no more for 105 years. The weather was fine during May 1769, but at the time of the Transit, the sky was overcast, and his 8-year wait was in vain. Think of that if your outdoor event is rained off! Worse followed. His return was further delayed, and he did not get back to Paris until October 1771. He found that his letters had not arrived, he had been declared legally dead, his wife had remarried, and his relatives had inherited his estate. However, he lived for another 21 years, remarried, and restored his reputation with publications on the Indian astronomy that he had learnt about during his stay there.

Further information

Wikipedia is informative about the Transits and Captain Cook. There is an article on Francis, with a paragraph on his brother George, in the Oxford Dictionary of National Biography, which you can access through the Norfolk Libraries website if you have a library card. There is a lot about William Hyde Wollaston at http://www.derehamhistory.com/william-hyde-wollaston---derehams-forgotten-scientist-b1766.html . George III's observatory still exists, and can be visited: see https://www.atlasobscura.com/places/kings-observatory . The papers presented to the Royal Society by Francis and by Thomas Hornsby are on line, and can be found by searching by author at https://royalsocietypublishing.org/search/advanced . There are two different methods described online to use the Transit times to calculate the distance to the Sun. One, which in my experience does not work well, is at https://www.youtube.com/watch?v=GwP8wCzbFLc&t=391s . A second is https://www.exploratorium.edu/venus/question4.html and a rather more complete (but still approximate version) of this method is https://vt2004.imcce.fr/en/fiches/fiche_n05_08_eng.html

Pondicherry is now called Puducherry. You can visit it, but make sure you have secured your flight home!