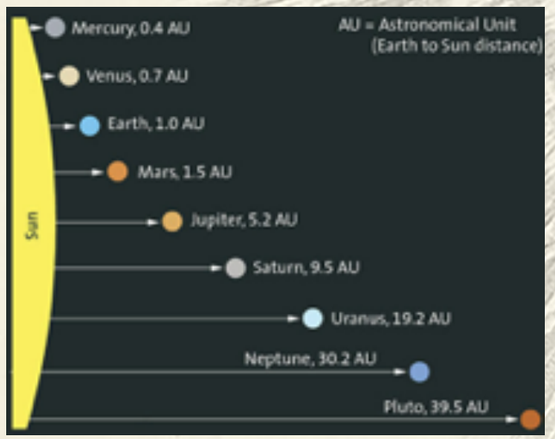
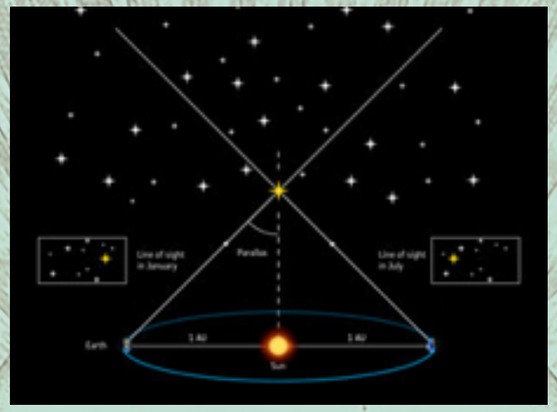
MEASURING THE UNIVERSE - EARLY IDEAS

How far away is the Sun and how do we know?

This may seem like an easy question to answer. Today we can find the answer by looking it up in a book or online. To answer the question we are about 1.5 million km away from the Sun. In the past it was a tricky measurement to make. Today astronomers can use technological advances such as radar to measure distances in space but in the past astronomers had to rely on maths and an optical effect called parallax to make the same calculation.

By 1619, German astronomer Johannes Kepler had worked out a ratio of how far each planet was from the Sun. He called these relative distances astronomical units or AU's. The Earth was one AU from the Sun, while Venus's distance was 0.72 AU, Mars's was 1.5 AU, and so on. If someone could work out the value of one AU they could figure out the distances between all the planets. The only problem was that no one know the value of one AU, so the ratios did not help astronomers work out how far away they were from us on Earth.





MEASURING THE UNIVERSE - STARS

Once a distance to the Sun and the planets had been found, astronomers turned their attention to measuring distances to the nearest stars. All the stars we can see in the night sky are part of our galaxy the Milky Way, but even so the nearest star is 40 trillion kilometres away. Astronomers cannot send a spacecraft to measure this, or use radar, so instead they have to use parallax, just like the astronomers did in the transit of Venus. The stars themselves only move a tiny amount against the background and powerful telescopes are needed to measure this. Recent spacecraft such as Gaia use parallax to measure with great accuracy.

WHAT IS PARALLAX?

Parallax is the movement of the background due to the position of the observer. We can all explore the concept of parallax by holding your finger out in front of your face and closing one eye. Look at where your finger is in relation to objects in the background. Now open the other eye, and close the first. The background moves! But it is not moving its just the location from where you view it from which has moved and this is how parallax works.

MEASURING THE UNIVERSE / JUSTIN WIGGAN / JOANNA MAYES (MAYES CREATIVE) / SWCTN

WRITTEN AND COMPILED BY **Carolyn Kennett (FRAS)** with **Mayes Creative** as part of the **Measuring the Univers** programme, which explores the ways we have tried to make sense of distances in the Universe and the part Cornwall played in making these measurements.

Mayes Creative. www.mayescreative.com

Carolyn Kennett is a writer and astronomer who lives in Cornwall and researches the links between ancient people and the stars.

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MEASURING THE UNIVERSE

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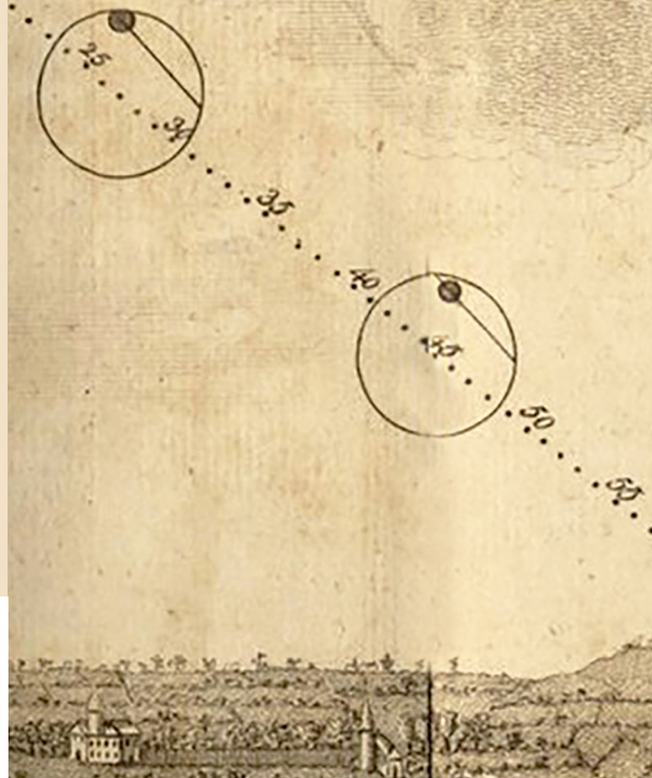
HOW FAR AWAY IS THE SUN?

THE CORNISH STORY OF THE 1761 AND 1769 TRANSIT OF VENUS.

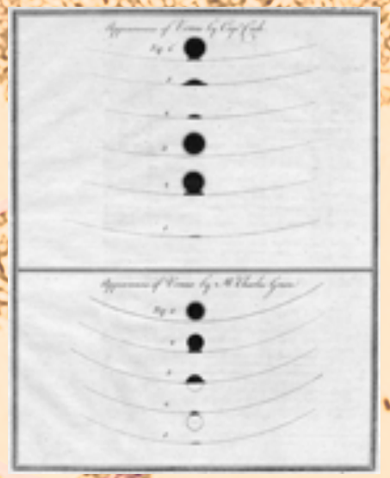
CAROLYN KENNETT (FRAS)



AN HISTORICAL ATTEMPT TO MEASURE THE SIZE OF THE UNIVERSE

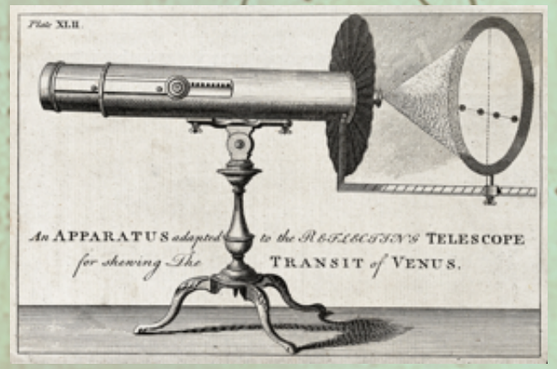
The years 1761 and 1769 presented 18th-century astronomers the opportunity to observe two transits of Venus within their lifetimes. Astronomer Edmund Halley worked out that a transit of Venus could be used to measure the size of the known universe, he died in 1742, 19 years before the 1761 transit of Venus. Other scientists used his idea and set out on journeys to the ends of the Earth to make the observations.

Their first attempt in 1761 didn't give very accurate results, so the astronomers were very keen to make the second attempt work. In 1769 the international astronomical community organised a mass-participation event on a far greater scale to anything attempted before. Astronomers were sent the length and breadth of the planet to watch the transit. Famously Captain Cook travelled to Tahiti on the ship Endeavour to witness it. Many other astronomers went on dangerous journeys to remote places to take part and not all of them were to return alive.



THE 1761 TRANSIT IN CORNWALL

In 1761 The Reverend Richard Haydon, Master of the Liskeard Grammar School Cornwall, measured the transit of Venus from his home. Haydon was educated at Pembroke College, Cambridge and he had an interest in mathematics and astronomy. He liked to carry out experiments as well as reading about theory in his books and he bought himself a number of astronomical instruments including telescopes. He was to make important observations of the transit of Venus in 1761 and calculated the longitude of Liskeard..



TRANSIT OF VENUS

A Transit of Venus is a spectacular astronomical event. It happens when Venus can be seen transiting across the face of the Sun. A Transit of Venus does not happen every year instead they come in pairs eight years apart and then there is not another one for over one hundred years.

THE 1769 TRANSIT IN CORNWALL

In the summer of 1769 John Bradley (1728–1794), astronomer, mathematician, and nephew of the third Astronomer Royal James Bradley, travelled to the Lizard Point from Portsmouth to view the transit of Venus. He was also paid to measure the longitude of Lizard Point, which was treacherous to mariners as they did not know its exact position on a map.

THE DAY OF THE TRANSIT 1769

Only the start of the transit was visible in the UK, as it began late in the evening and the Sun would set while the transit was in progress. Fortunately the sky was clear enough for him to observe the transit and for once in his visit the clouds stayed out of the way.

The following day he wrote about the observation.

"The first external contact of Venus was very exact as my eye was fixt on that part of the Sun where she first touch'd, but I saw no shade precede the body of the planet.....there appeared a confused sort of a light on the edge of Venus just coming on the Sun's limb, but whither it was the effect of an atmosphere, or occasioned by the great undulation in the air I do not pretend to know. A flying cloud at that instant hindred my sight for about 5" in time."

John had been lucky up to that point, the weather in Cornwall had been very poor with lots of cloud and fog.

JOHN BRADLEY'S TIME AT THE LIZARD

John Bradley stayed at the Lizard Lighthouse for a month. He made lots of other astronomical measurements including the position of stars, planets and the Moon. He experienced a lot of bad weather and complained that

'We have not had one day since we have been at the Lizard without some rain'

This weather did not make him very happy, his letters make it clear he was keen to travel home as soon as possible due to ill health.

'I cannot get rid of my rhumatism,' he added, but also wrote a more satisfied note than before about living conditions: *'We live very well, having a very good market 12 miles from hence where we send for what we want.'*

Here he is referring to the market town called Helston. Daniel Defoe during his grand tour of Britain had paid a visit to Helston 44 years prior and was similarly impressed, describing it as 'large and populous, and has four spacious streets, a handsome church, and a good trade'.