Solar eclipses offer opportunity for science, as well as for awe and wonder

March 23 2015, by Kevin Pimbblet

A lucky gap in the clouds. Credit: Kevin Pimbblet, Author provided

A solar eclipse is a rare event to witness first hand. A wag might add that once you've factored in the British weather they're rarer still, however observers in some areas of the UK managed to peer through the clouds

and experience a partial solar eclipse from Exeter and Truro in the South-West to Nottingham in the Midlands, and Hull and Newcastle and the North-East.

The reason solar eclipses are rare is due to the orbit of the moon around the Earth, which is inclined by about five degrees to Earth's orbit around the sun. This means that not only must the moon be a new moon in order to put it in the sky during daylight hours, but it must also be in just the correct arc of its orbit that it is aligned directly between the Earth and the sun.

A lunar eclipse, where the Earth comes between the sun and the moon, darkening the moon by blocking the sun's light, can be seen by most people on the dark side of the Earth. But not everyone on the daylight side of the Earth will see a solar eclipse, because the shadow of the moon on the Earth's surface covers only a band across the planet. To witness complete totality during an eclipse observers must be in an even more narrow band just 250km (150 miles) wide. This is why the best views were restricted to the islands of Svalbard and the Faroes this year.

Scientific opportunities in the dark

Scientifically speaking, eclipses have had a rich history in helping scientists conduct certain types of experiment and making unique discoveries.

A total solar eclipse was used to test gravity as described by Newtonian physics against predictions made by Einstein's new theory of General Relativity. Both forms of gravitation predict that light can be bent around the sun, but by different amounts. In order to see other celestial objects – such as background stars – near the disk of the sun, the only thing to do was await a total solar eclipse. This happened in 1919, when Arthur Eddington and others simultaneously made measurements of the

positions of stars close to the sun during an eclipse. They found that light was bent by the extent predicted by general relativity, rather than classical Newtonian physics. This proved to be the first of many spectacular successes for general relativity.

The sun is not the only celestial body to be eclipsed – or occulted – by the moon. In 1962, a lunar occultation technique was employed at the Parkes Telescope to determine that a quasar (a bright point-like object that appeared like a star) consisted of two elements. This use of occultations yielded the positions and further details of these elements which led to an astronomical revolution. Quasars are exceptionally powerful extra-galactic objects.

Eclipse concepts in use elsewhere

Today we can use the idea of occultations even to predict the weather. This uses Global Positioning Satellites (GPS) that constantly transmit their positions to listening stations worldwide. All that is required is for part of the atmosphere to occult and block the signal between one satellite and another. This results in refraction, where the radio signal is bent through the atmosphere. Critically, the amount of refraction is highly dependant upon the conditions in the atmosphere, for example water vapour density and ambient temperature. So based on these factors we can produce an instantaneous mapping of the current weather, and additional data to predict the future weather, based on the degree of refraction encountered.

Further away from home, we can use the idea of occultations to help derive the size of other planets orbiting distant stars. When a planet passes in front of a distant star in the line of sight to Earth, it creates an apparent partial eclipse that causes a dip in the observed light from that star. We can deduce the size of the planet by measuring how much light is blocked out during its transit.

So while solar eclipses are not a common sight, they're certainly an opportunity for scientists to learn more about the world and the laws that govern the Universe – naturally occurring phenomena that we're lucky to have the opportunity to observe from time to time.

Source: The Conversation