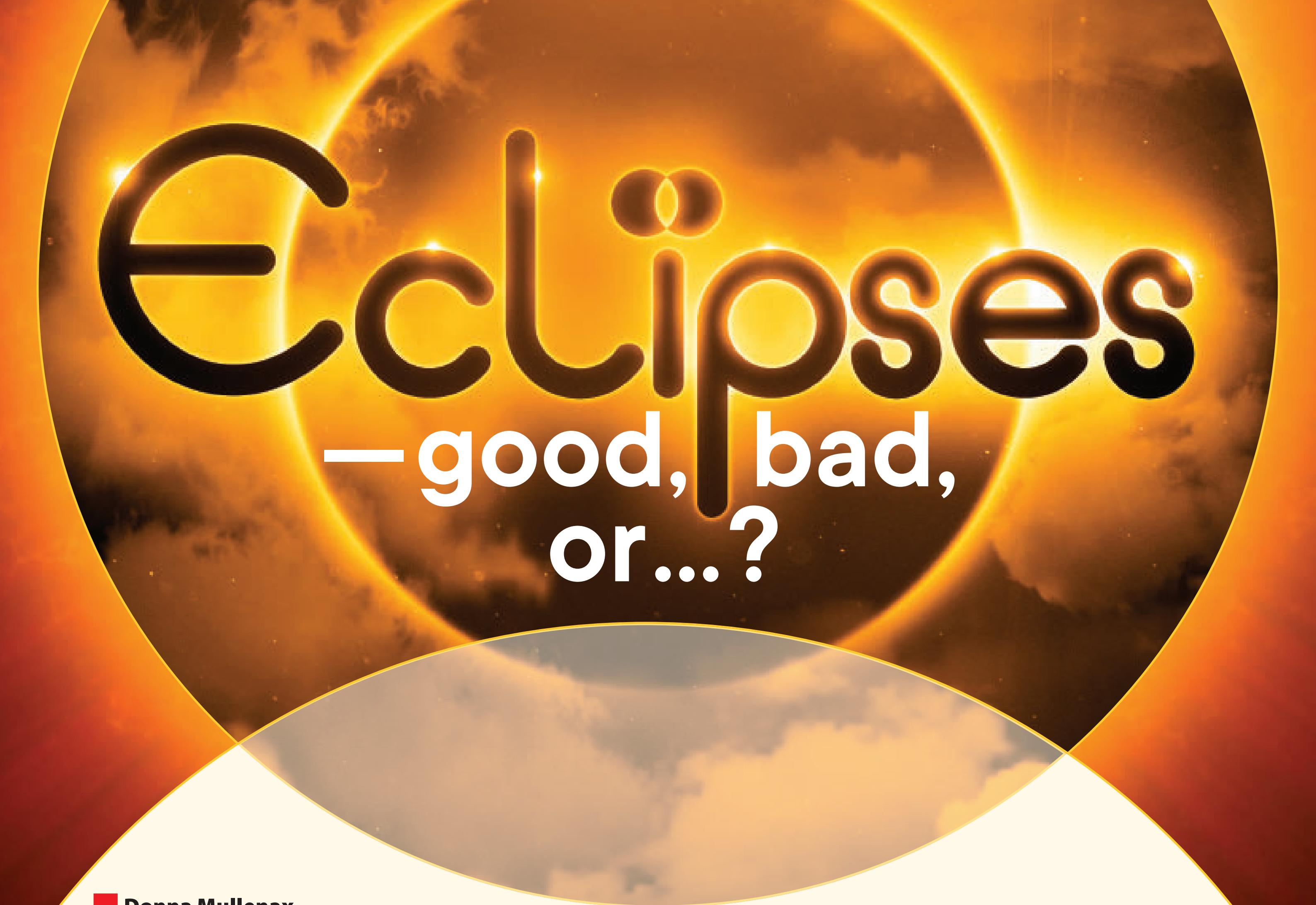

Eclipses —good, bad, or…?

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WHAT DO we know about all the dates listed below in sequence? What do they have in common?

BC
3 May 1375
15 June 763
AD
3 May 1715
28 July 1851
29 May 1919
21 September 1922
21 August 2017
20 April 2023
8 April 2024
AD (future)
26 December 2038
4 September 2100

Backgrounds: BlackNull | Envato Elements, and StrokeVorkz | Envato Elements

It seems a hard question, given the wide range of dates and with some in the future. How can we know specific dates of future events? On each of the dates in the past, a total eclipse of the sun occurred on some part of the earth's surface.[1] The future dates are when total solar eclipses are predicted from the motions of the earth, sun, and moon.

These awe-inspiring events have had impacts on science and history. Intending observers commonly schedule trips to the area of the predicted eclipse years in advance.

Lunar eclipses

Before returning to our focus here on solar eclipses, there is a second type of eclipse called lunar (for moon). Lunar eclipses (figs 1 & 2) and solar eclipses (fig. 3) both require the sun, moon, and earth to be aligned.

There are about two to four lunar eclipses per year on average, though any given one will not be visible everywhere.

Most full moons do not result in a lunar eclipse, because the full moon is not usually aligned with the sun and earth. This is because of the 5° angle the moon's orbit is 'tilted' with respect to the ecliptic (the plane in which the earth orbits the sun).

Lunar eclipses last for hours because the earth's shadow is so much larger than the moon's diameter. On the other hand, solar eclipses, which are much rarer, last only minutes. They occur when the new moon casts a shadow on the earth's surface.

The moon's shadow is much smaller than the earth. So the region where *totality* can be experienced at some point during any given solar eclipse (i.e. where the moon as seen from earth is temporarily covering the sun, blocking the sun's rays from reaching the observer) is less than 1% of the earth's surface.

Fig. 1. A lunar eclipse occurs during a full moon, when the earth is between the sun and the moon. In a total lunar eclipse, as here, the moon is entirely in the earth's umbra (shadow), so only indirect light reaches the moon, giving a 'blood moon' effect (fig. 2).

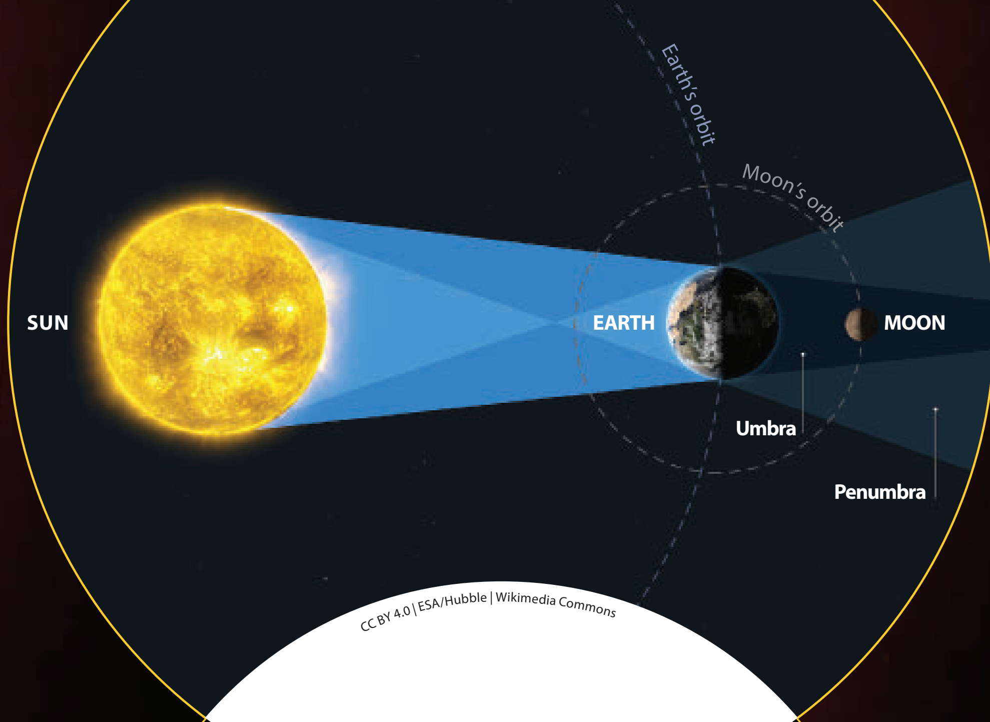
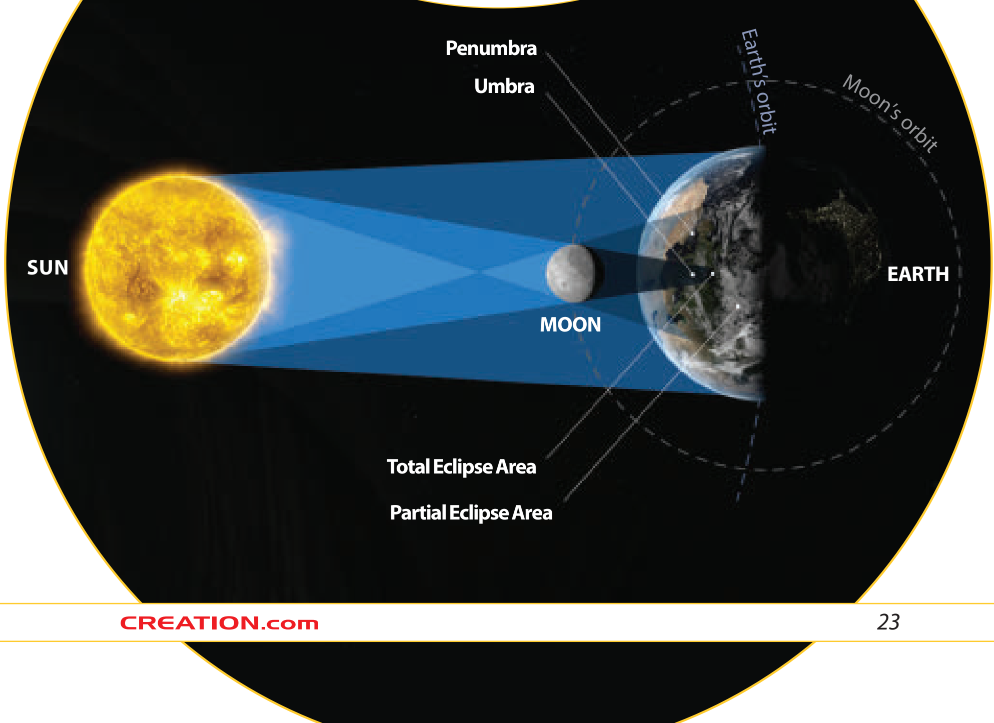


Fig. 2. A 'blood moon', as viewed from Australia by telescope. This occurs in a total lunar eclipse (fig.1) because only the indirect sunlight that has been bent by our atmosphere passes through it to the lunar surface. The blue and green wavelengths are scattered into our sky, so the only wavelengths left to light up the moon are the orange and red.

Fig. 3 (below, right). A total solar eclipse occurs during a new moon. The umbra (shadow) is where sunlight is totally blocked; the outer penumbra is where it is only partially blocked.



Solar eclipses—a rare wonder

Since most of the earth is covered with water, the *path of totality* (the path travelled by the moon's shadow as it sweeps across the earth) is usually over water. So it's not surprising that many people never experience a total solar eclipse. Solar eclipses are such a wonder that cruise companies schedule excursions for ships to be in the path of totality.[2]

A total solar eclipse requires perfect alignment of the sun, moon, and earth. Without perfect alignment, a portion of the sun will remain unblocked by the moon. This results in only a partial solar eclipse, which often goes unnoticed because the sky barely darkens.

Additionally, the moon must be at its prime distance from the earth. How does the moon's distance contribute?

Fig. 4. An annular (ring) eclipse occurs when the moon is too far away from the earth for it to completely cover the sun's disc as seen from Earth.

Fig. 5. A total solar eclipse over the La Silla Observatory in Chile, which experienced nearly two minutes of totality, on 2 July 2019.

The moon and earth obey the Laws of Planetary Motion formulated by the great creationist scientist, Johannes Kepler (1571–1630), who recognized that the orbits of the earth and moon are ellipses, not circles. (He also calculated that God created the universe in 3993 BC.[3]) So, there are times the moon is farther from the earth than at other times.

Clench your fist with your thumb pointing up. With one eye closed and your elbow bent, find something in the room that your thumb just covers, like a clock or picture on the wall. Now, move your thumb away from you. What happens? The thumb no longer completely covers the object, so the edges become visible. So, if the moon is too far away, the total eclipse becomes instead an *annular eclipse* (from the Latin *annulus* = 'ring').

This is a spectacular sight. The edge of the sun remains visible around the outside of the moon, producing the so-called 'ring of fire' (fig. 4). (*Always* use proper solar (eclipse) glasses to view a solar eclipse, to avoid eye damage.)

Amazing arrangement

The sun is some 400 times larger than the moon but is also about 400 times farther away. This 'perfect arrangement' allows the possibility of a total solar eclipse, which is when the moon's diameter, as seen from Earth, is exactly the same as the sun's. Which means it can completely cover the sun, yet remain small enough to allow the sun's 'atmosphere' including the inner *chromosphere* and outer *corona*, to become visible. This has greatly improved humanity's knowledge of many aspects of the sun. This combination requires very fine tuning.

During a total solar eclipse, the *umbra* (darkest part of the moon's shadow, representing the region of totality—fig. 3) moves rapidly across the Earth, reaching speeds of over 1,600 km/h (1,000 mph). Its path is called the *path of totality*. You must be in this path to see the sun totally eclipsed by the moon. It is typically 16,000 km (10,000 miles) long, but its width is never more than 300 km (190 miles), and generally around half that.

With such specific requirements needed for a total solar eclipse, how can future dates and paths be known with certainty? Interested readers might like to consult the detailed online supplement to this article, 'Mathematics of eclipses', at creation.com/math-eclipses.

Historical impact

Scientifically, eclipses have been used to determine the shape of the moon, measure the distances from the earth to the moon and from the earth to the sun, study changes in the earth's rotational period, and study the sun's corona. (The corona is, surprisingly, hundreds of times hotter than the sun's surface: 1–3 million kelvin, while the surface is 'only' 5,800 K.) Scientists also used solar eclipses to test Einstein's Theory of General Relativity.

Historically, eclipses have had mixed reactions, see 'Eclipse beliefs' p. 26. There have been attempts to use eclipses to date historical events. The oldest record of a total solar eclipse in Mesopotamia was 1375 BC. Nineveh experienced a total solar eclipse on 15 June 763 BC. This eclipse, documented on an ancient tablet, was used by historians to confirm the accuracy of the chronological systems used in the Old Testament.[4]

There are several references in Scripture to the sun and moon darkening. One that is often misidentified concerns the Crucifixion. Some believe that when the sun darkened from the 6th hour to the 9th hour, the cause was a total solar eclipse. But solar eclipses only last minutes, not hours. Also, they occur at the new moon, while the Crucifixion was just after Passover, celebrated during a full moon, on the opposite side of its orbit. Nothing is beyond our Creator, of course, but this also means He does not require an eclipse to have the sun darken. One can confidently say that the darkening of the sun at the Crucifixion was not a normal eclipse.

In his *Antiquities*, Josephus mentions a lunar eclipse.[5] This has been used in attempts to date the death of Herod and the birth of Jesus.

Herodotus claimed the Medes and Lydians came to a ceasefire because of the total solar eclipse on 28 May, 585 BC.[6] Around 450 BC, Meton of Athens predicted a lunar cycle of 235 months that would result in lunar eclipses at the same location every 19 years based on the solar calendar. The Greeks demonstrated their skill in studying the heavens with the

Antikythera Mechanism, an ancient calculating mechanism discovered in 1901. Constructed between 150–100 BC, it was used to track the motions of the sun, moon, and the five then-known planets (Mercury, Venus, Mars, Jupiter, and Saturn). The Antikythera Mechanism could also predict solar and lunar eclipses.[7] Another 'tool' early people may have used in efforts to predict eclipses is Stonehenge.[8,9]

Impacting science

The 21 September 1922 Australian eclipse was one of the better known eclipses in 'modern' history because of its location (rural and rarely cloudy) and its impact on science. With some progress made towards confirming Einstein's Theory of General Relativity during the 1919 solar eclipse, the focus of the world turned to Australia in 1922. Researchers travelled from around the world to record the sky before, during, and after the eclipse.[10] This was no small feat; travel from England to Australia took at least 40 days, and the first flight from America was still six years away. Yet, people planned in great detail and were able to confirm that Einstein was correct in his prediction that strong gravity would bend light. Astronomers showed that the sun's gravity bent starlight beams passing close to the sun, and by the amount Einstein predicted.

Present day

With the progress in travel by land, air, and water over the last 100 years, more people can place themselves in the path of totality. At the time of writing in late 2023, the world has its eyes on the United States and Mexico for the 8 April 2024 total solar eclipse, the path of which will travel from the Pacific Ocean, across Mexico, and through the United States before entering southeastern Canada.[11] The exact times are known for every location. Travel plans have been made, and cruises booked.

Future

Using pattern recognition, NASA can predict eclipses covering a span of a thousand years in advance.[12] NASA then uses these predictions to produce maps of eclipse paths over a twenty-year period. The current one, 2021–2040, shows four future total solar eclipses in Australia: 2028, 2035, 2037, and 2038.[13] How far ahead do people look? I already have the 2052 solar eclipse on my calendar because it will pass over my house in the US. Only the Lord knows if I will get to see it.

Evolutionary view

Evolutionists know the detailed precision needed for a total solar eclipse. Yet, they see eclipses as the product of chance, not the planning of the Creator.

NASA says:

> That we often get such impressive solar eclipses on Earth is a lucky chance of nature.[13]

Scientific American:

> So is there some great significance to the fact that we humans just happen to exist at a time when the moon and sun appear almost identically large in our skies? Nope, we're just landing in a window of opportunity that's probably about 100 million years wide, nothing obviously special, just rather good luck.[14]

Conclusion

Eclipses are awesome phenomena. They add to the evidence that our universe did not happen by chance, but was created by the all-powerful, all-knowing God. Johannes Kepler, who believed that God created the earth as described in Genesis, said it well:

> The chief aim of all investigations of the external world should be to discover the rational order and harmony which has been imposed on it by God and which He revealed to us in the language of mathematics.[15]

Observing and studying eclipses gives us a small glimpse into the mighty work God did in the creation of the universe.

References and notes

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