

Scientific—and social—dimensions of the 2024 total solar eclipse

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On Monday, April 8, the Moon will pass directly between Earth and the Sun, briefly turning day into night in what is arguably the most dramatic astronomical event for those of us on Earth—a total solar eclipse.

Such events happen with predictable regularity, on average once every 18 months. They are extraordinarily well studied and understood; there will be a total of 68 total solar eclipses in the 21st century and a further 582 through the 30th century. While hundreds of millions will be able to watch the partial phases of tomorrow's eclipse, the path of totality is a much more focused swath that is 16,000 kilometers (9,941.9 miles) long and at most 198 kilometers (123 miles) wide.

The eclipse will begin in the South Pacific Ocean before making landfall in Mexico, passing through the states of Sinaloa, Durango and Coahuila. Maximum eclipse, where one can experience the longest length of totality, will occur in Nazas, Mexico, lasting 4 minutes 28 seconds.

The Moon's shadow will then travel across 13 states in the United States, including Texas, Oklahoma, Arkansas, Missouri, Illinois, Kentucky, Indiana, Ohio, Pennsylvania, New York, Vermont, New Hampshire, before finally going through Maine. It will also pass over parts of Ontario, Quebec, New Brunswick, Prince Edward Island and Cape Breton in Canada.

For those who will experience the full eclipse, the sky will steadily dim as the amount of light reaching the ground will be reduced to what one would experience on Mars, Jupiter, Saturn and beyond, until the Moon totally blocks all direct light from the Sun. The region is cast into an artificial night, the temperature drops sharply and a red glow like sunset appears on the horizon in every direction.

In addition to the contemporary indication of broad

interest in events that are objective, universal and not manufactured by the media, eclipses also have significant historical relevance. One of the earliest recorded instances of an eclipse is from a clay tablet found in the remains of the ancient city of Ugarit, dating back to 5 March 1,223 BCE. That record has been used to help narrow down the time frame during which Ugarit, located in what is now Syria, was destroyed. Records from a similar time period in Anyang, China wrote, "The Sun has been eaten."

Such old eclipses are also used to measure the slowing of Earth's rotation, which is known to occur as a result of tidal interactions between Earth and the Moon. We can predict where eclipses would occur if Earth's rotation had not slowed. In Anyang, they would have occurred thousands of miles away, allowing astronomers to conclude that since about 1,200 BCE, Earth's rotation has slowed by 47-thousandths of a second per day.

For many thousands of years, both solar and lunar eclipses (when the Moon passes into Earth's shadow) were seen as mysterious, often mystical events. They occur over specific points on Earth over such long timescales that they can seem random and unexplainable.

The foundation for understanding eclipses was solidified only when Isaac Newton published his *Principia* in 1687, which generalized the understanding of planetary motion with calculus. From then, the relative motion of Earth, the Moon and the Sun were not only known but calculable for years in advance. The first time a solar eclipse was predicted was a short 28 years later, when Edmund Halley (of Halley's Comet) predicted a solar eclipse over London on May 3, 1715 to a path error of about 20 miles and a time error of about 4 minutes.

In the more modern era, eclipses have helped spur the understanding that the Sun has different atmospheric layers, the chromosphere and the corona. Ongoing solar studies and the development of optics in the 1800s led to the discovery of the element helium in 1868 by two independent researchers, Norman Lockyer and Jules Janssen, before the Russian chemist Dimitri Mendeleev finalized the periodic table in 1869. It would be another 27 years before helium (from the Greek *helios*, literally “Sun”) would be isolated and studied on Earth.

The most famous use of an eclipse to study astronomical phenomenon occurred in 1919. Four years previously, Albert Einstein published his finished work on general relativity, of which one consequence is that the high gravity of stars is capable of bending the path of light. To test this prediction, Arthur Eddington traveled to the island of Principe, in the Gulf of Guinea near Nigeria, to view the May 29 total solar eclipse and attempt to image stars which, if general relativity were incorrect, would be invisible.

In one of the great scientific triumphs of the 20th century, Eddington did show a shift in the position of the light coming from those stars, matching the predictions of general relativity.

The interest in studying the Sun has given rise to even more in-depth studies. A flotilla of spacecraft, including the venerable Solar and Heliospheric Observatory and the relatively recent Solar Dynamics Observatory, observe the Sun on an essentially constant basis. And the Parker Solar Probe, launched in 2018, now makes regular measurements from inside the Sun’s corona, approaching as close as 6.9 million kilometers from the Sun’s surface.

Through this study, astronomers have developed a more general understanding of other stars, as well as how the energy output of the Sun impacts Earth, from enchanting *aurora borealis* and *aurora australis* to the potential disruption caused by solar flares and coronal mass ejections and the ongoing and accelerating climate catastrophe.

Of course, the immense scientific significance of the study of the Sun and the wide popular understanding of this physical reality stands in sharp contrast to a broader scientific understanding of other aspects of society, closer to home. Giant corporations and capitalist politicians deny the reality of climate change, even though its effects can be modeled mathematically

and predicted with an accuracy approaching that of astronomical phenomena.

Millions are gathering in the narrow band of totality even as the coronavirus pandemic still rages. The vast majority will be unmasked, thanks to the backward medical policies of the Biden administration and corporate America as a whole. The same scientific, materialist outlook that predicts the exact path and time of the eclipse also predicts that thousands of people will contract COVID-19 as a result of unsafe travel to and from the eclipse-viewing region.

A scientific perspective can also be applied to economic life and society in general. And it was so done by Karl Marx, Friedrich Engels, Vladimir Lenin, Leon Trotsky, the founders of modern Marxism, and their successors and continuators in the 21st century.

Only Marxism is able to explain the profound contradictions between the great scientific achievements of the 20th and 21st centuries, expressed in the powerful growth of the productive forces on a world scale, and the continued existence of capitalist private ownership and the outmoded system of rival nation-states, which threaten humanity with the specter of economic crisis, dictatorship and war. Only Marxism provides a revolutionary road forward for the international working class.



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