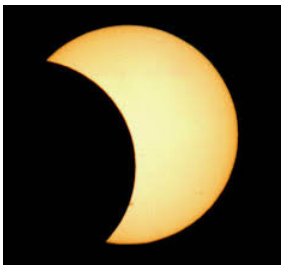
Spring-Summer 2016
Volume 64
Issue 4

# The Observer

The Newsletter of Central Valley Astronomers of Fresno

## In This Issue

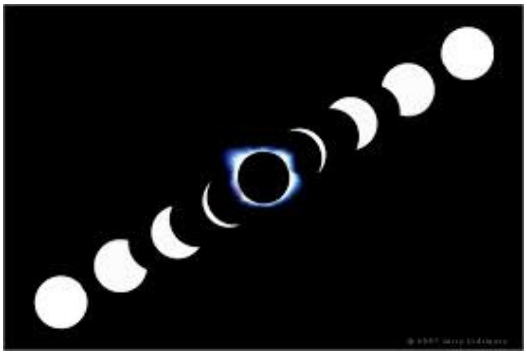




## Special Issue
## The 2017 Total Solar Eclipse

### An Explanation And Some Information

After the May-June 2016 issue came out, which included an article discussing the August 21, 2017 total solar eclipse as the first in the country in many years, several CVA members wrote to say that that was not exactly true. They especially pointed to the 1979 total solar eclipse, which did in fact, have its totality path go through (granted, a small )part of the U.S. Others noted several more total eclipses which, if they did not have their path of totality in the U.S., at least were partially seen in the U.S. So, it's valid to say that, yes, there were total solar eclipses in the U.S. after the 1960s. The August 21, 2017 eclipse, though, is special. It will be the first total solar eclipse to have its path of totality entirely in the U.S., from one coast to another, in almost 100 years. In fact, the last total eclipse to have its totality path run completely through the U.S. occurred on June 8, 1918.



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*The Observer* is the newsletter of the Central Valley Astronomers of Fresno

# Astronomy Quote of the Month

"My idea worked. I wanted to keep things as they were till the eclipse was total, otherwise they would be trying again to get me to dismiss the darkness, and of course I couldn't do it. Sending for the clothes gained some delay, but not enough. So I had to make another excuse. I said it would be but natural if the king should change his mind and repent to some extent of what he had done under excitement; therefore I would let the darkness grow a while, and if at the end of a reasonable time the king had kept his mind the same, the darkness should be dismissed. Neither the king nor anybody else was satisfied with that arrangement, but I had to stick to my point.

"It grew darker and darker and blacker and blacker, while I struggled with those awkward sixth-century clothes. It got to be pitch dark, at last, and the multitude groaned with horror to feel the cold uncanny night breezes fan through the place and see the stars come out and twinkle in the sky. At last the eclipse was total, and I was very glad of it, but everybody else was in misery; which was quite natural. I said:

'The king, by his silence, still stands to the terms.' Then I lifted up my hands—stood just so a moment—then I said, with the most awful solemnity: 'Let the enchantment dissolve and pass harmlessly away!'

"There was no response, for a moment, in that deep darkness and that graveyard hush. But when the silver rim of the sun pushed itself out, a moment or two later, the assemblage broke loose with a vast shout and came pouring down like a deluge to smother me with blessings and gratitude..."

From *A Connecticut Yankee in King Arthur's Court*
By Mark Twain, 1889

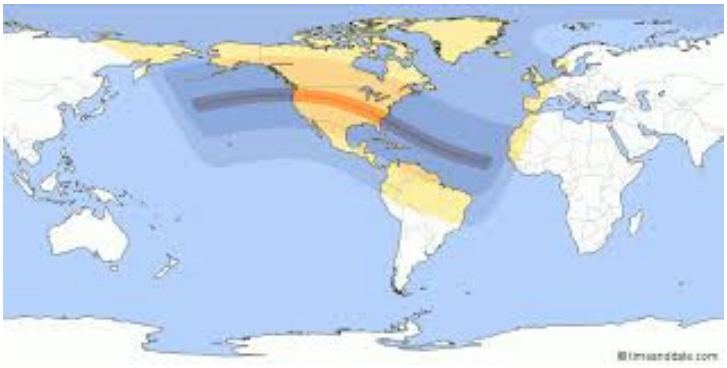
In the story, the narrator goes back in time, to 528 AD in England, when the legendary King Arthur rules. At one point, he is accused of treason and witchcraft and sentenced to be burned at the stake. He remembers, however, that a total solar eclipse is supposed to happen on the day of his execution, and just as he is about to be put on the pyre, it occurs. The people think that he controls the Sun, and release him.

This is based on a true event: there was a solar eclipse in 528 AD which did have its path of totality through England, and Twain made it part of his story.

## Number of extra-solar planets found as of May 2016-2,085
## How many more are out there-tens of thousands?
## Hundreds of thousands?

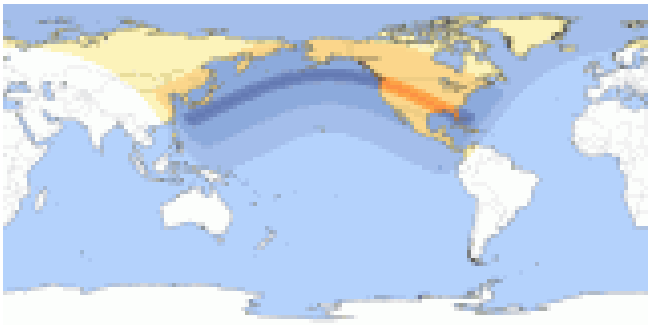
# The 2017 Total Solar Eclipse

The August 21, 2017 eclipse will begin off the northwest coast of the U.S. Its path of totality will enter the mainland between Salem and Corvallis, Oregon, race through the northern Rockies into the Midwest, increasingly moving south, then through the southern states, and exit the U.S. mainland just north of Charleston, South Carolina. The eclipse's longest period of totality will be 2 minutes 41 seconds near Carbondale, Illinois.



Above-the eclipse's complete path on August 21, 2017

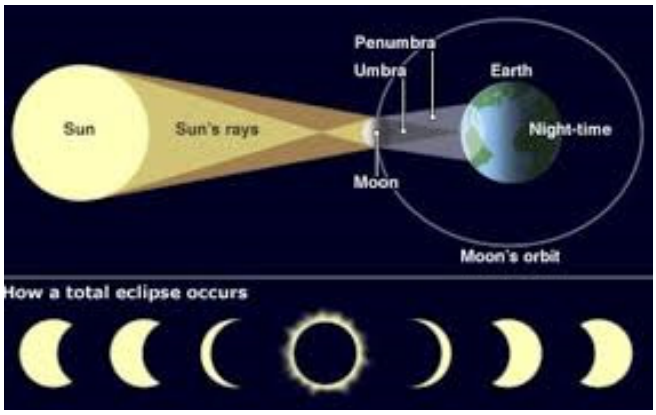

Above-the 2017 eclipse's totality path through the U.S. The red and green pins mark what are considered the best and longest viewing areas.



Above-the path of the June 8, 1918 total solar eclipse

# What Causes a Solar Eclipse?

Generally speaking, a solar eclipse occurs when the Earth's Moon comes between the Sun and the Earth. One of the great coincidences of science is that the Moon, about 240,000 miles from Earth, and the Sun, roughly 93 million miles from Earth, appear to be the same size in the sky as seen from Earth.* Every now and then, usually twice a year and sometimes more often,** due to orbital mechanics, their paths will intersect with the Moon being in front of the Sun on a New Moon day. This is when a solar eclipse takes place. Solar eclipses will usually last between two and four hours, from the first interference of the Moon with the Sun's light to totality to the waning of the Moon and complete Sunlight again.




# Different Kinds of Solar Eclipses

Scientists generally describe three different types of solar eclipses:

Total Solar Eclipse-This is when the Moon completely blocks out the sun for a period of time, usually between two and six minutes. The sky will go completely dark, and many cases, stars can be seen.

Partial Solar Eclipse-As the term implies, the Moon only partially blocks out the Sun. Depending on the degree of partial blockage, the sky may turn slightly dim, but not totally dark, or it may remain bright.

Annular Solar Eclipse-This is also called a Ring Eclipse. The moon will completely come between the Earth and the Sun, but it is not quite large enough due to its orbital position, to completely cover the Sun's surface. Therefore, there will be a ring of sunlight seen at maximum coverage.

A fourth type is sometimes called a Hybrid Eclipse-This is when the eclipse shifts during its path from a partial to an annular eclipse, or vice versa(this may happen several times during the eclipse). These are very unusual.

Eclipses will always travel west to east.

Throughout the recorded history of solar eclipses, total eclipses have occurred slightly more often than partial and annular. On average, a century will have 240 solar eclipses, a little more than two per year.


*In 1969, the Apollo 12 astronauts on the way to the Moon observed a rare type of solar eclipse: that of the Earth eclipsing the Sun. Also, in 2006, the Cassini spacecraft observed and recorded Saturn eclipsing the Sun.

**There have been times in which up to five solar eclipses, the maximum that can occur, have been seen in a single year. These happen irregularly, but average about once every 100 years. The last time this occurred was in 1935, when five solar eclipses, four partial and one annular, took place. The next year with five eclipses will be in 2206 AD.

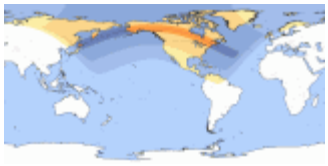
# Solar Eclipses Seen in the U.S. since 1960

September 20, 1960-Partial solar eclipse-centered from Siberia through the Canadian Arctic and the Midwest U.S., seen in much of U.S.

February 4, 1962-Total solar eclipse-centered in Pacific Ocean, partially seen on west coast of U.S.

July31, 1962-Annular solar eclipse-centered in South America and Africa, partially seen in southeast U.S.

July 20, 1963-Total solar eclipse-centered in northern Canada, seen partially in much of U.S.(right)



May 9, 1967-Partial solar eclipse-centered in the Arctic, partially seen in most of U.S.

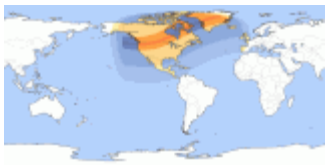
September 11, 1969-Annular solar eclipse-centered in N. Pacific to South America, partially seen in U.S.

July 10, 1972-Total solar eclipse-centered in Siberia to N. Canada, partially seen in most of U.S. (right)

December 24, 1973-Annular solar eclipse-centered in Central America to Africa, partially seen in Midwest and east U.S.

October 12, 1977-Total solar eclipse-centered North Pacific to South America, partially seen in most of U.S.(right)

February 26, 1979-Total solar eclipse-centered in northwest U.S. to Northern Canada, seen at least partially in all of U.S.(right)

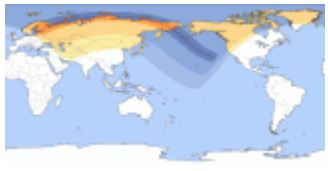


May 30, 1984-Annular solar eclipse-centered in Central Pacific to Africa, seen totally in southeast U.S., partially seen in most of U.S.

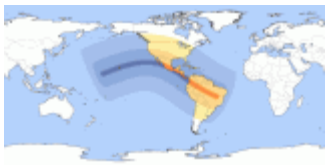
October 3, 1986-Total solar eclipse-centered in Greenland and northern Canada, partially seen in all but west coast of U.S.(right)

March 7, 1989-Partial solar eclipse-centered in Arctic, partially seen throughout most of U.S.

July 22, 1990-Total solar eclipse-centered in northern Siberia to central Pacific, partially seen in northwest U.S.(right)



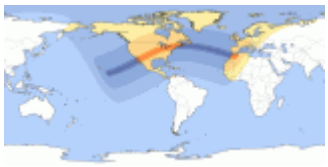
July 11, 1991-Total solar eclipse-centered in Pacific Ocean to Mexico and Brazil, partially seen in most of U.S.(right)



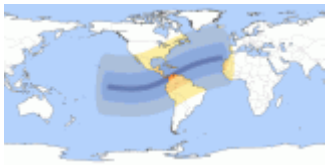
January 4, 1992-Annular solar eclipse-centered in East Pacific to just off U.S. west coast, partially seen on west coast of U.S.

May 21, 1993-Partial solar eclipse-centered in Arctic, partially seen in most of U.S.

May 10, 1994-Annular solar eclipse-centered in Pacific Ocean through southeast U.S. to Africa, at least partially seen throughout most of U.S.(right)



February 26, 1998-Total solar eclipse-centered in central Pacific to South America to Africa, partially seen in Midwest and eastern U.S.(right)



July 31, 2000-Partial solar eclipse-centered in Arctic, partially seen in northwest U.S.

December 25, 2000-Partial solar eclipse-centered from North Pacific Ocean across Canada to North Atlantic Ocean, seen in most of U.S.

June 10, 2002-Annular solar eclipse-centered Philippines to Mexico, partially seen in most of U.S. (right)

April 8, 2005-Total solar eclipse-centered from New Zealand to northern South America, partially seen in the southeast U.S.

May 20, 2012-Annular(or hybrid) solar eclipse-centered in east Asia to southern U.S.-at least partially seen in most of U.S.(right)

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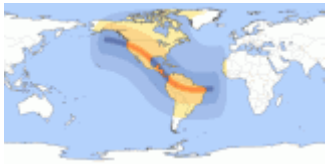
## After 2017



October 14, 2023-Annular solar eclipse-centered off northwest U.S. coast to Brazil, seen throughout U.S.(right)

April 8, 2024-Total solar eclipse-centered South Pacific to New England and North Atlantic, seen throughout the U.S.(right)

All maps from www.timeanddate.com

# Francis Baily 1774-1844

Baily was born and raised in Berkshire, England. As a teen, he worked for the famous English scientist Joseph Priestly, and was impressed by the discipline and mysteries of science. Afterwards, he spent his early adult years wandering through Canada and the United States. Returning to England in 1799, he settled into a career as a businessman and stock market expert. He wrote several books about business and investing, and eventually became so successful in the business world that he was able to retire in 1825 and devote the rest of his life to his scientific interests, especially astronomy.

Although he made several major scientific discoveries, Baily is best known for the phenomenon known as "Baily's Beads," which he observed and recorded during the solar eclipse of May 15, 1836 in England. This event, in which sunlight peeks through the valleys and ridges at the Moon's edge just before total occultation, had been noticed before, but Baily was the first to record it and understand why it happens. He was able to verify his observations during another total solar eclipse in Italy on July 8, 1842.

Baily also worked with pendulums, and from them calculated the elliptical properties of the Earth. He also calculated the mean density of the Earth. In addition, Baily played a major role in the revision of the *Nautical Almanac* in 1829, and in the 1830s was responsible for revising and updating several major star catalogues, including those of LaLande, de Lacaille, Mayer, Ptolemy, Tycho Brahe, Halley, and Hevelius. He also played a leading role in the researching and writing of the Royal Astronomical Society's own star catalogue. Baily as well edited, catalogued, and had published John Flamsteed's letters and scientific notebooks.

Baily was one of the founders of the Royal Astronomical Society in 1820, and served as its first president. He would subsequently serve three more times as president as well. He was also one of the first foreign members of the American Academy of Arts and Sciences. A crater on the Moon and an asteroid are named after him.

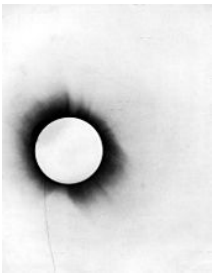
Sources-Wikipedia

Berkshirehistory.com

# Solar Eclipse Confirms Einstein's Theory of Light and Gravity

In 1918, Frank Dyson, the Astronomer Royal asked Arthur Eddington, then one of the world's leading physicists, to lead an expedition to the island of Principe, off the west coast of Africa, to observe the total solar eclipse of May 29, 1919. Eddington's main goal was to see if gravity bent light, in this case the light of stars near the Sun, as theorized by Albert Einstein's General Theory of Relativity. Confirmation would be a major step in proving Einstein's concepts. Eddington agreed, and the expedition left in early 1919. Eddington also sent a second expedition to Brazil, also along the eclipse's totality path, in case the Africa site was clouded or rained out.

(Dyson actually had far more ulterior motives for sending Eddington to Africa. During World War I, Eddington, who was a Quaker and a pacifist, refused to do any kind of military or war related work as an expression of conscience. Also, he angered the British government and some of the scientific establishment in 1915 by giving then German citizen Albert Einstein's paper on general relativity a favorable review. As a result, the government was considering putting him on trial for disloyalty, which would have ruined his career. In reality, Dyson sent Eddington to Principe to keep him out of prison.)



Fortunately, at both sites, clear weather prevailed on May 29, and Eddington and his assistants got good images of the eclipse with stars in the background. By measuring their positions relative to the Sun, Eddington was able to determine that their positions were distorted and their light bent due to the Sun's gravity. He discovered what today is called gravitational lensing, and confirmed Einstein's ideas about light and gravity. Images taken by the second expedition in Brazil reinforced his finding. When the discovery was announced in late 1919, Einstein went from being a unknown young scientist to a world renowned figure, and would be awarded the Nobel Prize in 1921 (but not for general relativity; he won it for the photoelectric effect, which was another discovery he made during his research into relativity). In the end, Eddington was never charged by the government. He died in 1944, at the time England's most famous scientist.

Left-Einstein and Eddington; Top left-Eddington; Right-Eddington's 1919 solar eclipse image

# Some Common Terms Used with Solar Eclipses

First Contact-When the Moon's leading edge appears to touch the Sun's surface for the first time

Second Contact-When the Sun is almost covered by the Moon

Totality-when the Sun is completely covered by the Moon

Third Contact-when the moon starts to move away from the Sun-the first glimmer of sunlight from the edge of the Moon's covering

Fourth Contact-When the Moon's trailing edge breaks away total from the Sun; the eclipse is ended

Occult-when the Moon covers the Sun, either totally or partially

"Diamond Ring" Effect-when the Sun that is otherwise totally covered by the Moon shines through the Moon's valleys and ridges, creating bright points of light for a minute or so. This occurs almost at second contact, and sometimes at third contact as well. These are also known as "Bailey's Beads," in honor of the British astronomer Francis Bailey(1774-1844) who first described them.

Umbria-The area of totality of an eclipse that follows a path across the Earth's surface

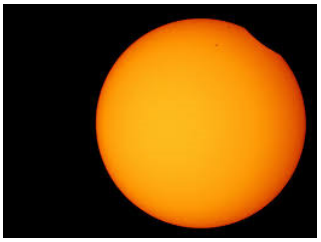
Penumbria-The entire area of the solar eclipse across the Earth's surface

Syzygy-A conjunction of the Sun and the Moon viewed from Earth. This can only occur during a New Moon.

"Diamond ring" effect

"Bailey's Beads" effect

Totality



First Contact

Second Contact

Third Contact

Fourth contact

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