The Great American Solar Eclipse

Collection of weblinks on eclipse at https://physicsweb.creighton.edu/

Overview:
• What you can expect to see and where to see it.
• Why eclipses are so rare and spectacular to see (astronomy behind eclipses)
• How to SAFELY view the eclipse
• Assorted things that make eclipses really cool!
What will you see?

• It depends on WHERE you are viewing from and WHEN you are viewing.

• **Total Solar Eclipse**: visible ONLY within the ~70 mile wide path that will sweep across the U.S. from West to East (in ~90 minutes total)

• Duration of total eclipse <2.5 minutes
TOTAL SOLAR ECLIPSE OVER NEBRASKA ON AUGUST 21, 2017

The sight of a lifetime  Don’t miss it!

DIFFERENT PHASES OF A TOTAL SOLAR ECLIPSE

NASA
What will you see?
If you are NOT in path of Totality

• **Partial Solar Eclipse:** Everyone in the U.S. will see a partial eclipse of the Sun
• The closer you are to the “Path of Totality” the larger the % of the sun will be eclipsed at maximum
  - in Omaha, 98% of the sun will be eclipsed at maximum
• But, totality is an entirely UNIQUE experience
...it gets about 10,000 times darker when the moon covers the last 1 percent of the sun's surface!

If you ARE viewing in the Path of Totality:
HIGHLY RECOMMENDED IF POSSIBLE

• Moon will gradually move in front of the Sun
• As totality approaches, you will see:
  - “Bailey’s Beads”: streams of sunlight gleaming through the cliffs and terrain of the Moon & “Diamond Ring Effect”
• **At totality:** Solar Corona, sky darkens, stars appear, animals confused, Eerie light!
What causes an eclipse: The Astronomy of Eclipses

Our Place in the Universe

YouTube link to the video: https://www.youtube.com/watch?v=17jymDn0W6U
FIRST: The causes of Eclipses and Moon Phases are NOT the same

• MOON PHASES are due to relative position of Earth-Moon-Sun
• Moon phases go through a full cycle every ~28 days due to Moon’s orbit around the Earth

• Half of the Moon is always lit up by sun (day) half dark
• We see a different fraction of that lit up part as it orbits around us

Eclipses

• The Earth & Moon cast shadows.
• When either passes through the other’s shadow, we have an eclipse.
• Why don’t we have an eclipse every full & new Moon?
• Moon’s orbit tilted 5° to ecliptic plane
  – Crosses ecliptic plane only at the two nodes
  – Eclipse possible only when full/new occur near nodes

Solar Eclipses between 2011-2023

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Another Correction: The Moon doesn’t move in a perfect circle around the Earth (slightly elliptical)
- During some eclipses, the moon is slightly further away and doesn’t fully cover the Sun – “Annular Eclipse”
- TOTAL Solar eclipses are visible from somewhere on Earth every 1 – 2 years
Summary: Why am I excited about this eclipse....

- Striking visual and sensory experience!
  - the CROWN JEWEL of sky watching & most dramatic Natural phenomenon to observe

- Very RARE to see a total eclipse

- Gives a unique sense of our Natural World, Laws and forces of nature that shape our universe
  - appreciate the sheer awesomeness of the Universe and at the same time the incredible scientific achievements of humanity!
Viewing the Eclipse Safety: VERY IMPORTANT!

• Most people will use Solar Eclipse glasses:
  - should not be able to see ANYTHING except the Sun
  - look for ISO number 12312-2
  - THESE ARE NOT TOYS!
  - wear them OUTSIDE of eyeglasses

• See links on Creighton University Physics website
  (American Astronomical Society has tested glasses from
  many vendors for safety)
Viewing the Eclipse Safety: VERY IMPORTANT!

More advanced filter viewing options:
- “Solar telescopes”
- regular night-sky telescopes with SAFE filters (made for the telescope) placed IN FRONT of the mirror/lens

Filters Always go IN FRONT of any lenses or mirrors

EYE SAFETY DURING AN ECLIPSE

1. PARTIAL ECLIPSE • GLASSES ON
The eclipse begins when the sun's disk is partially blocked by the moon. This partial eclipse phase can last over an hour.

2. DIAMOND RING • GLASSES ON
Shortly before totality, the crescent sun converges into a single brilliant “diamond” of sunlight as the last bit of the sun's bright disk shines along the edge of the moon, while the first glimpses of the faint corona create a “ring” around the moon.

3. BALLY'S BEADS • GLASSES ON
In the last little moment before totality, you may see the “diamond ring” break up into “beads” created as the sun's light shines through the low-lying valleys along the edge of the moon. These are called Bally's Beads.

4. TOTALITY • GLASSES OFF
Once the Bally's Beads disappear and the moon completely covers the entire disk of the sun, you may safely look at the eclipse without a solar filter. Be careful to protect your eyes again before the end of totality—the total eclipse may last less than a minute in some locations.

5. FINAL STAGES • GLASSES ON
A crescent will begin to grow on the opposite side of the sun from where the diamond ring appeared at the beginning. This crescent is the lower atmosphere of the sun, beginning to peek out from behind the moon and it is your signal to stop looking directly at the eclipse. Make sure you have safety glasses back on—or are otherwise watching the eclipse through a safe, indirect method—before the first flash of sunlight appears around the edges of the moon.

Images: 1, 2, 4, 5 Credit: Rick Farnham; TravelQuest International and Wilderness Travel
Indirect Viewing

- Project image of sun through a “pinhole” (i.e., a simple hole in a piece of paper):
  - Simple:
    - Or Fancy:
Photography of the Eclipse?

My recommendation: IF you are viewing in the Path of Totality, during the brief special minutes of Totality:
PUT YOUR PHONES AND CAMERAS AWAY
and EXPERIENCE THE EVENT

There will be many many many beautiful images of the eclipse online, taken with professional equipment and by professional photographers for you to enjoy, download, print, etc.

But even these will not capture the experience of observing it
Taking photos w/ smartphone

... But you might want to take pictures during PARTIAL ECLIPSE:
-- Buy a solar filter or use your eclipse glasses (NOT regular sunglasses) as a solar filter to cover your smartphone lens during the early part of the eclipse.
-- Use a tripod to keep your camera stable.
-- If you want to take pictures of the stuff going on around you during the eclipse, use a low light level setting or download a special app that lets you manually adjust exposure speed.
-- Practice! Take photos just after sunset during twilight to get an idea of what the light levels will be like during totality.
-- Shoot photos of the moon to learn how to manually adjust the focus on your camera.
-- Get real! Camera phones were meant for selfies and such. Don't expect amazing eclipse photos from your smartphone.

A cosmic coincidence: Consider the scale of the solar system

Sun and planets to scale
An Important Eclipse from History

- Confirming Einstein’s General Theory of Relativity: The total solar eclipse of 1919

In 1915, Einstein proposed a revolutionary theory of gravity, space and time: Mass warps space, and warped space tells objects how to move

Confirming General Relativity

- The shift is VERY small:
  - the size of a quarter held ~2 miles away!
  - was detected by Arthur Eddington

- Now we see the warping of space on grand, cosmological scales (called “Gravitational Lensing”)
First Picture of an Eclipse on the continent?


Recurrence of Eclipse Patterns: The Saros Cycles

The Saros arises from a natural harmony between three of the Moon's orbital periods:

- Synodic Month (New Moon to New Moon) = 29.530589 days
- Anomalistic Month (perigee to perigee) = 27.554550 days
- Draconic Month (node to node) = 27.212221 days

These three cycles match roughly every 6,585 days (or 18 + years)

Thus the eclipse path on the Earth’s surface will be similar every 18+ years)
Saros Cycles

Some Past and Future Eclipses of Saros 145

©1999 Fred Espenak

Courtesy of "Totality - Eclipses of the Sun" by Littmann, Willcoxon and Espenak