Celestial Shadows – Eclipses of the Sun and Moon

November 8, 2023

Howard J. Simkover, P.Eng.

OPCUG

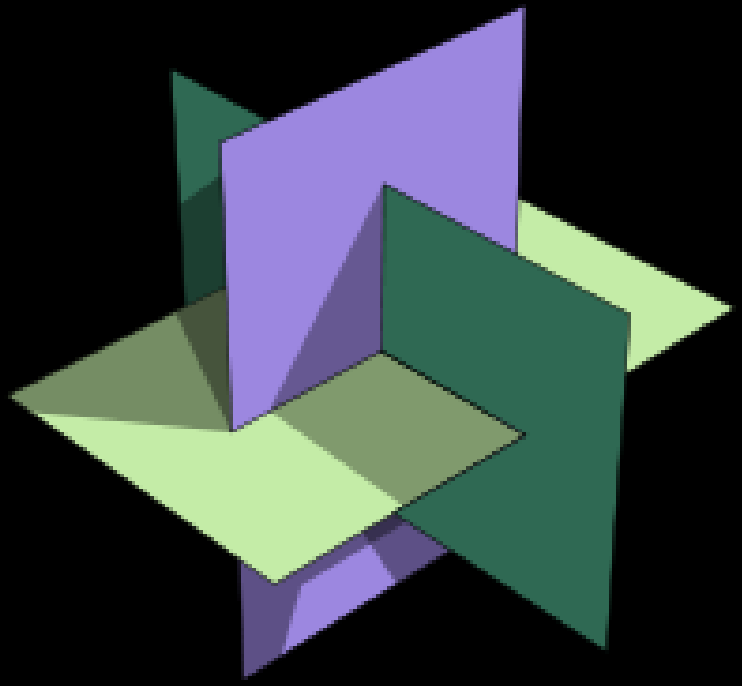
Users helping users

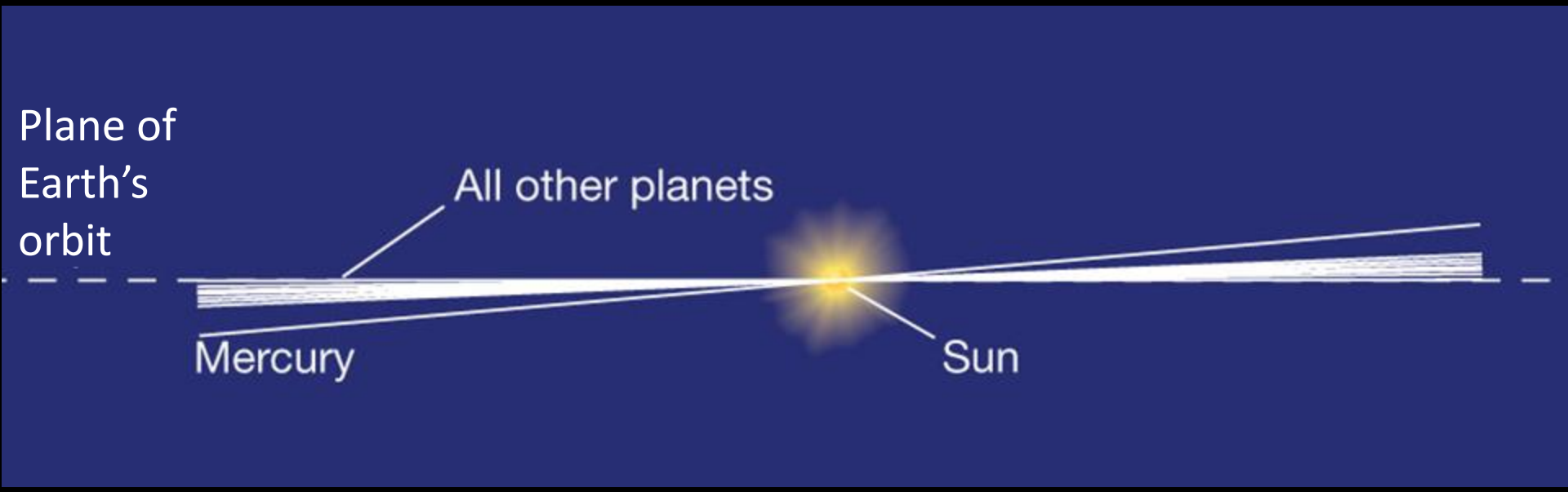
for over 40 years

Eclipses are all about:

- alignments
- shadows

Alignments can happen because most solar system objects orbit in nearly the same plane

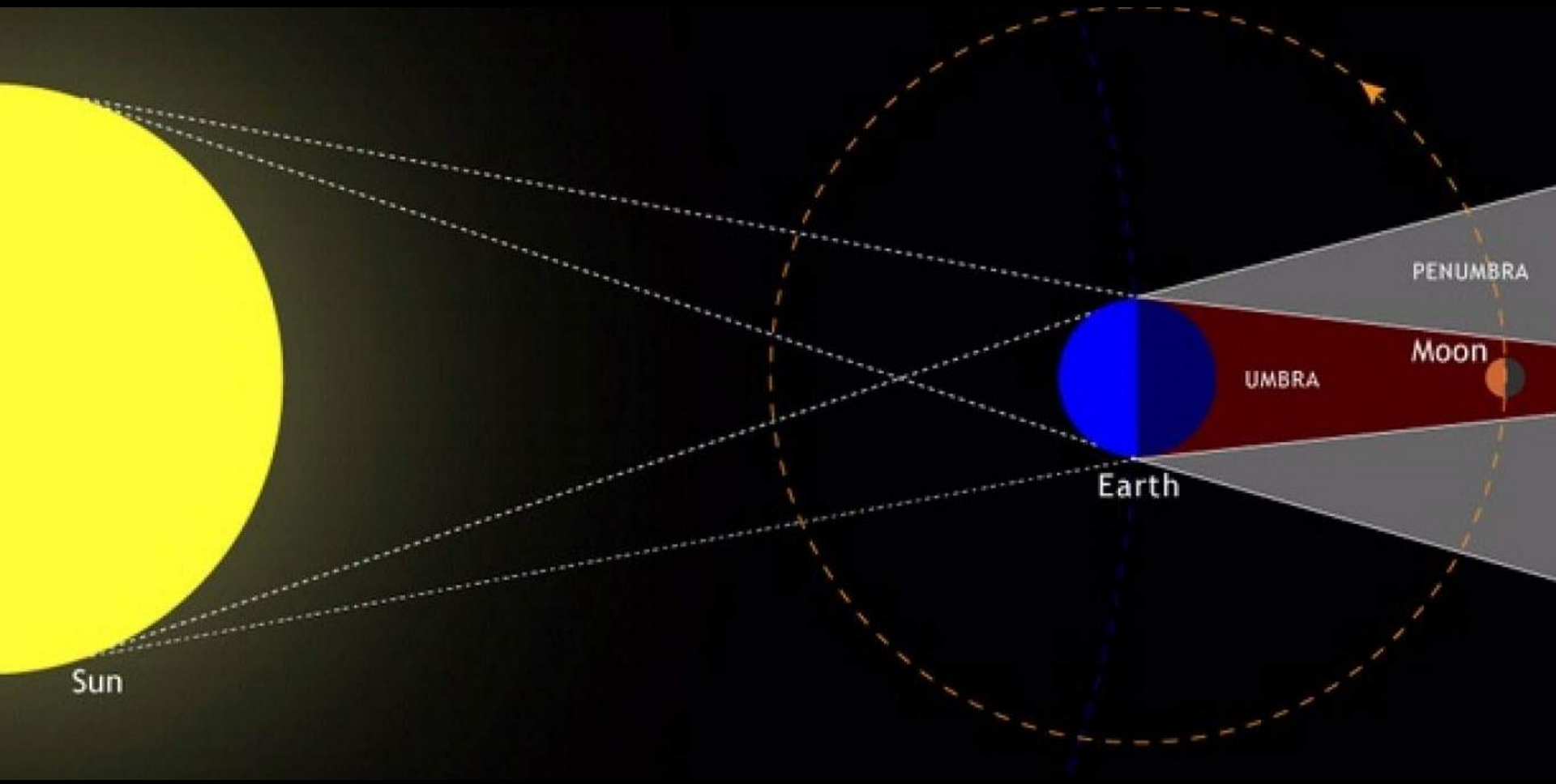




This situation is what leads to solar system alignments in our sky

Eclipses of the Moon

The Earth's shadow on the Moon


PENUMBRA
Moon
UMBRA
Earth
Sun

We've had three lunar eclipses visible from Canada in the past 2 years:

- November 19, 2021
- May 15, 2022
- November 8, 2022

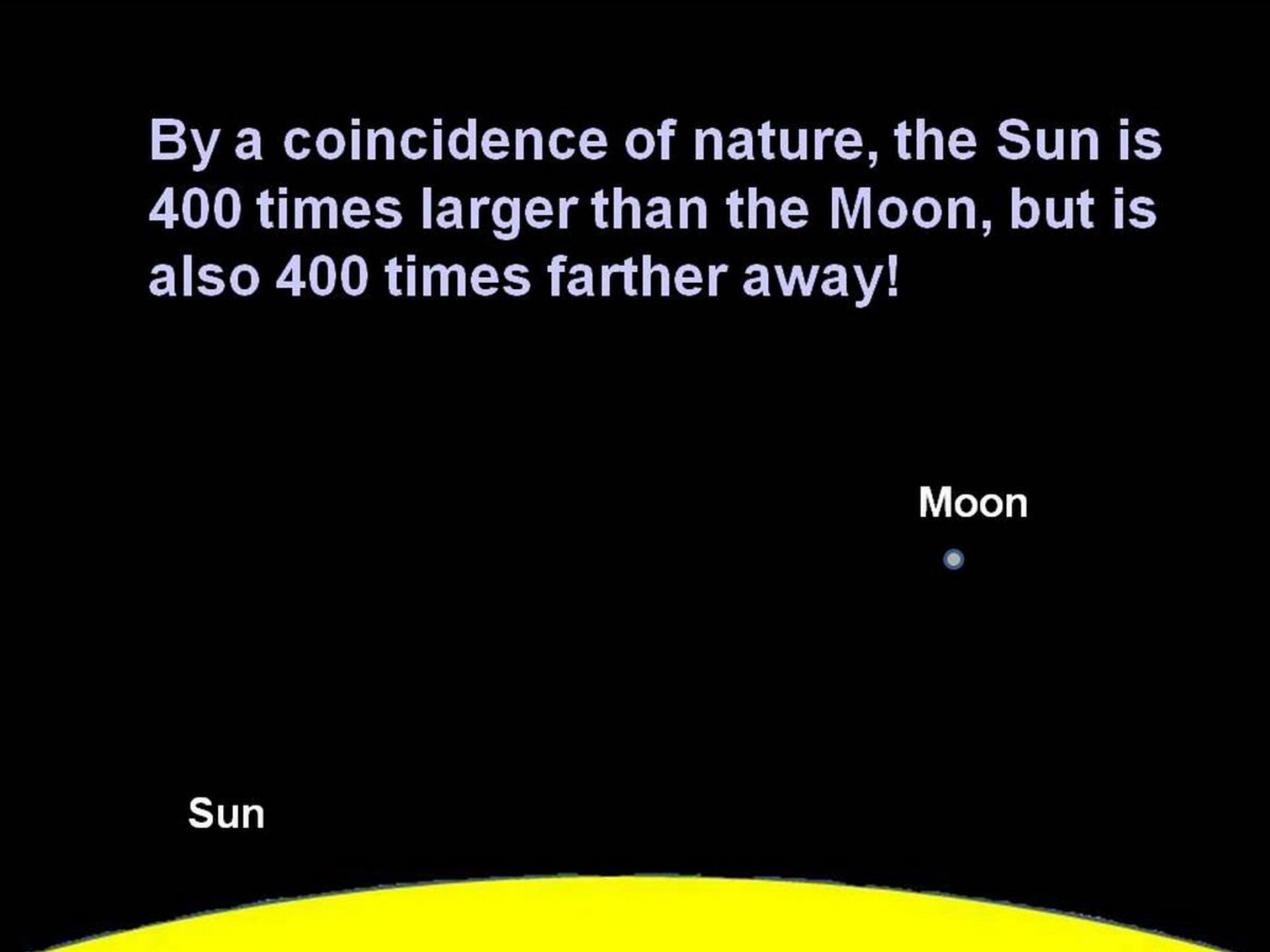
When is the next one that we can see?

March 14, 2025

Eclipses of the Sun

The Moon's shadow on the Earth

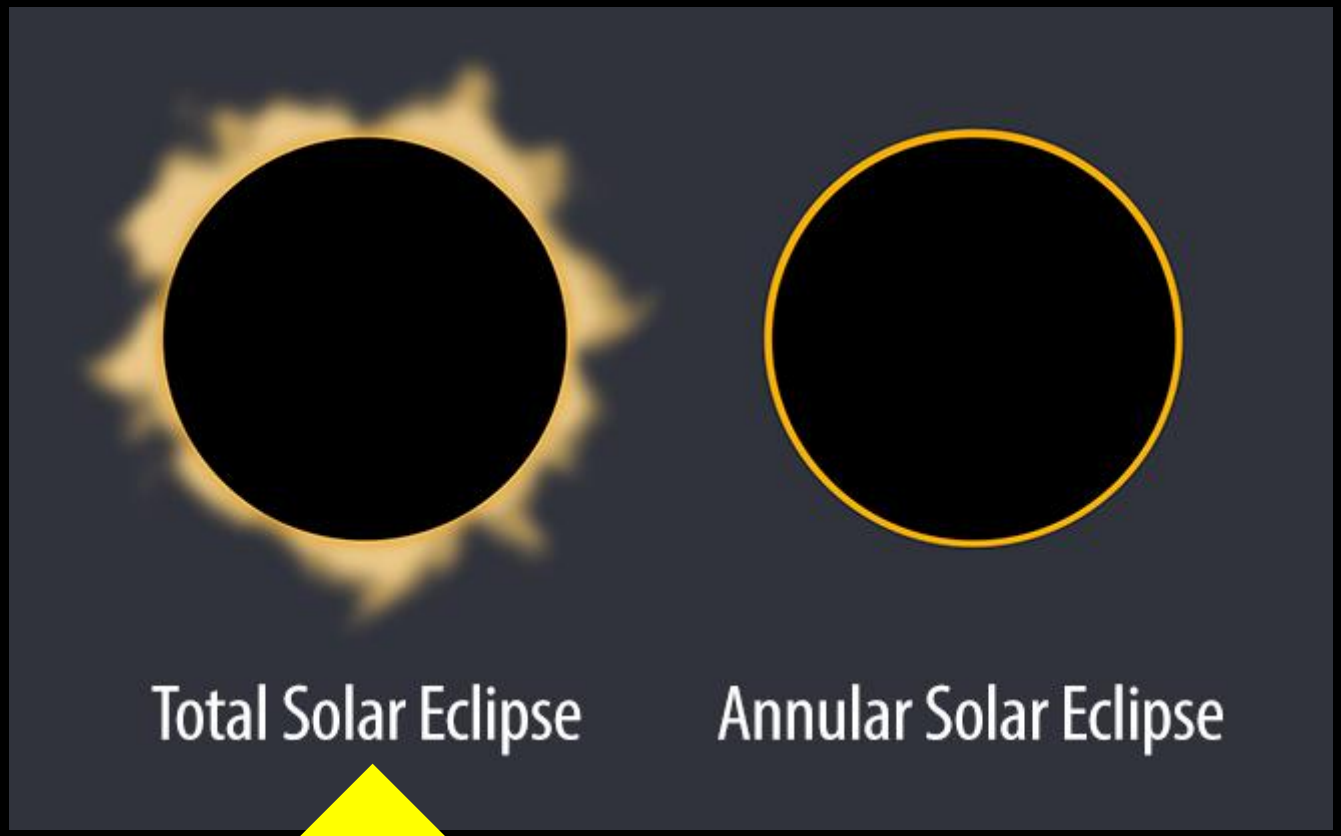
By a coincidence of nature, the Sun is 400 times larger than the Moon, but is also 400 times farther away!

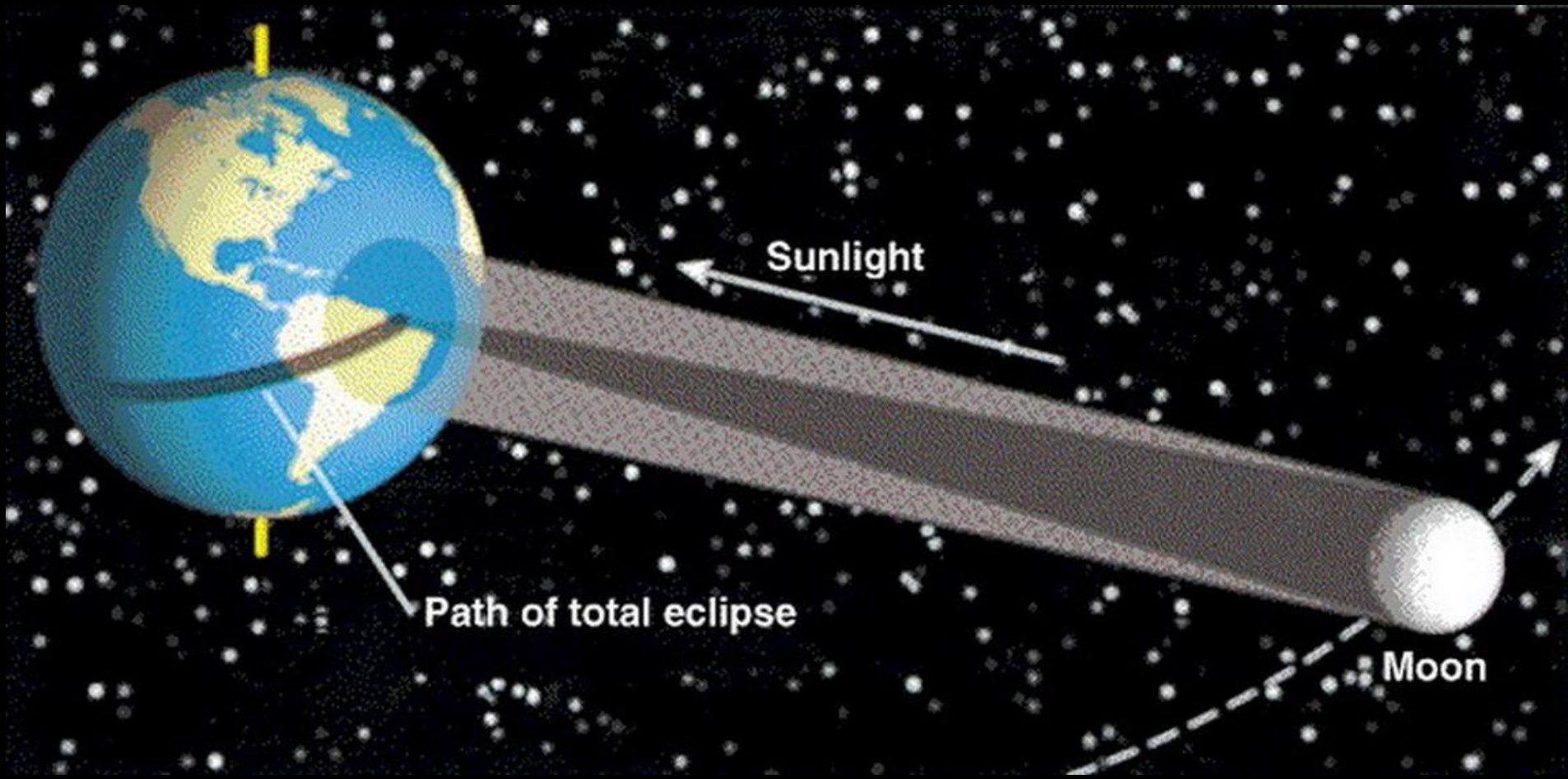


Therefore, in the sky they appear to be almost exactly the same size!

This means if the alignment is just right, the Moon can BARELY cover up the Sun.

Types of Solar Eclipses




Sunlight
Path of total eclipse
Moon

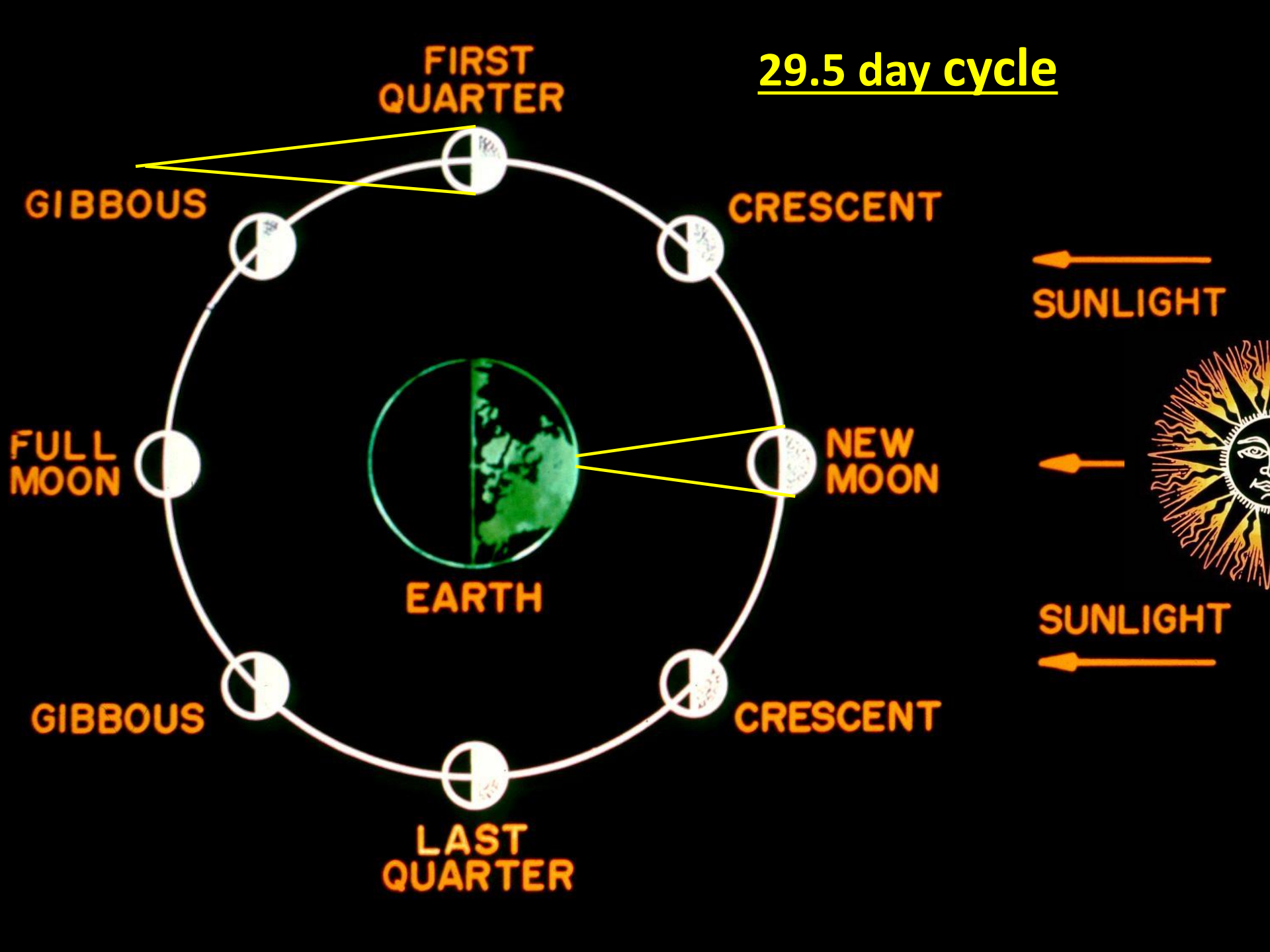
Question: Are total eclipses of the sun rare?

Answer: "Yes and no"

For any one location:
Once in about 360 years

For the Earth as a whole:
Once in about 18 months

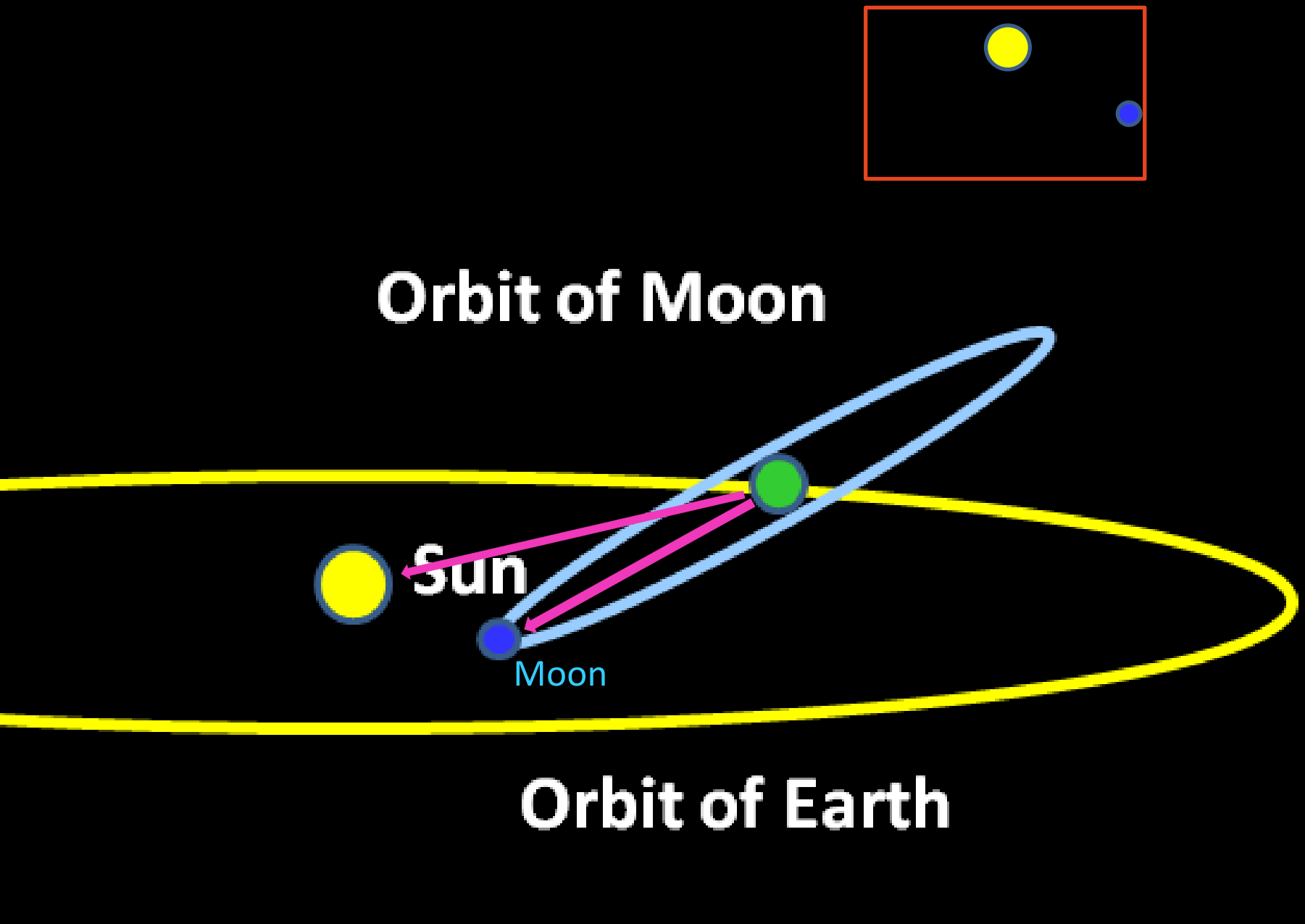
An eclipse of the sun can happen ONLY at the time of "New Moon"


29.5 day cycle
FIRST QUARTER
GIBBOUS
CRESCENT
SUNLIGHT
FULL MOON
NEW MOON
EARTH
SUNLIGHT
GIBBOUS
CRESCENT
LAST QUARTER

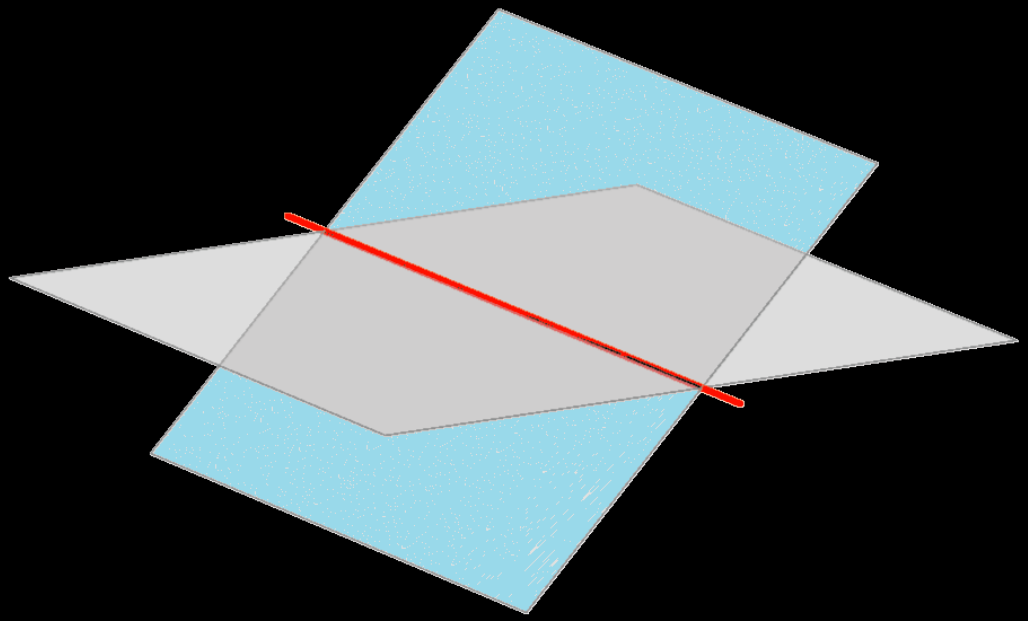
If an eclipse of the sun can happen ONLY at New Moon, then:

Why don't we have an eclipse EVERY MONTH, at New Moon?

It's because the orbit of the Moon is inclined to the orbit of the Earth


Orbit of Moon
Sun
Moon
Orbit of Earth

For some sort of eclipse to occur, the Earth and the Moon must be near the points in their orbits where the **orbital planes intersect**



This situation occurs twice per year, but even then you are not guaranteed to get a total eclipse. It might be a partial eclipse.

Edmond Halley
1656 - 1742

May 3, 1715


A Description of the Passage of the Shadow of the Moon over England,
In the Total Eclipse of the SUN on the 22d Day of April 1715 in the Morning.
THE GERMAN SEA
SCOTLAND
THE
IRISH SEA
IRELAND
St. GEORGE'S CHANNEL
THE CHANNEL
FRANCE

Solar Eclipses in Movies

- Courtship of the Sun and Moon, 1907
- King Solomon's Mines, 1937
- Fantasia, 1940
- A Connecticut Yankee in King Arthur's Court, 1949
- Barrabas, 1961
- 2001: A Space Odyssey, 1968
- Dragonslayer, 1981
- Dolores Claiborne, 1995

The Sun and Moon appear to move in a repeating pattern in the sky

The pattern repeats in 18 years, 11 days and 8 hours

This period is called the “saros”

Successive eclipses in a saros are shifted 1/3 of the way around the Earth

Saros #139

- 71 eclipses
- May 17, 1501 – July 3, 2763
  (1,262 years)

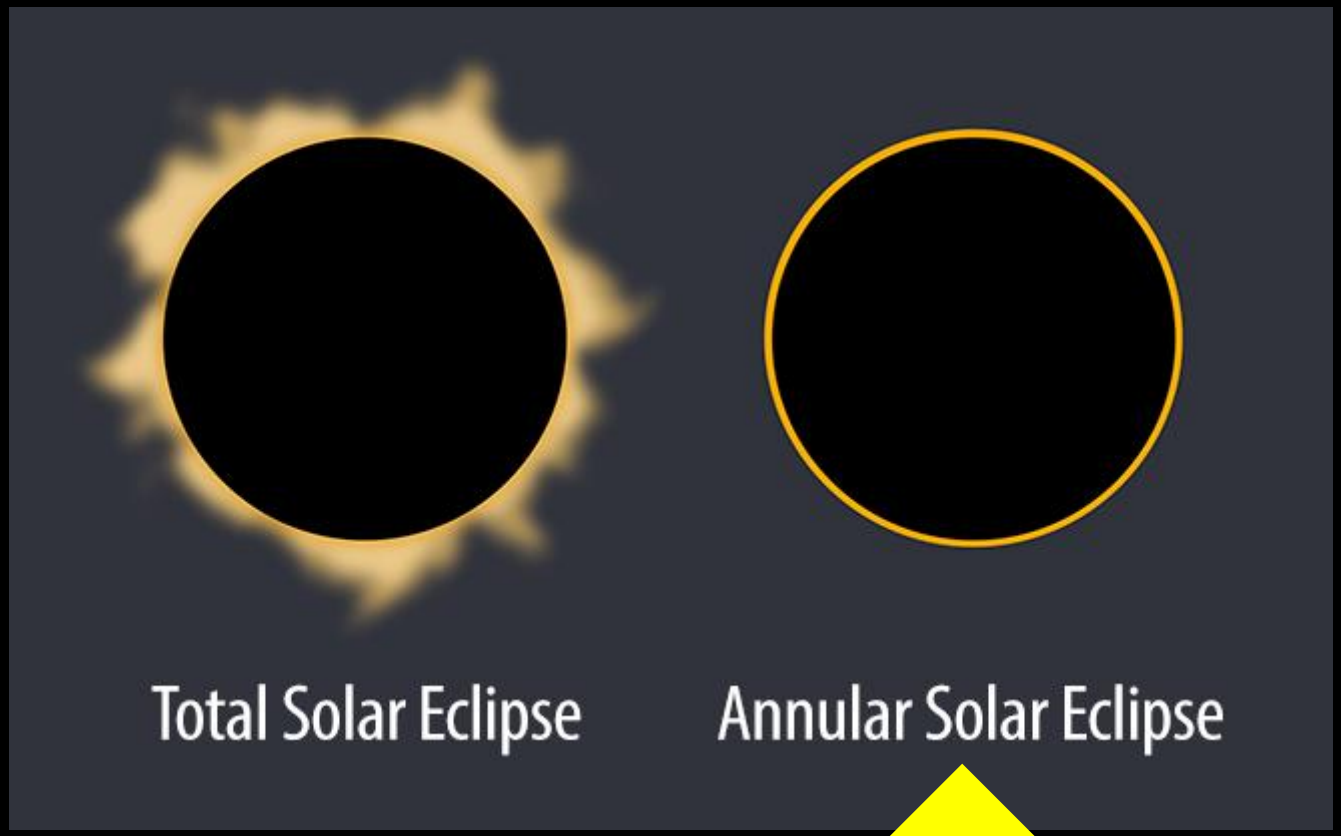
4 Successive Eclipses in Saros #139

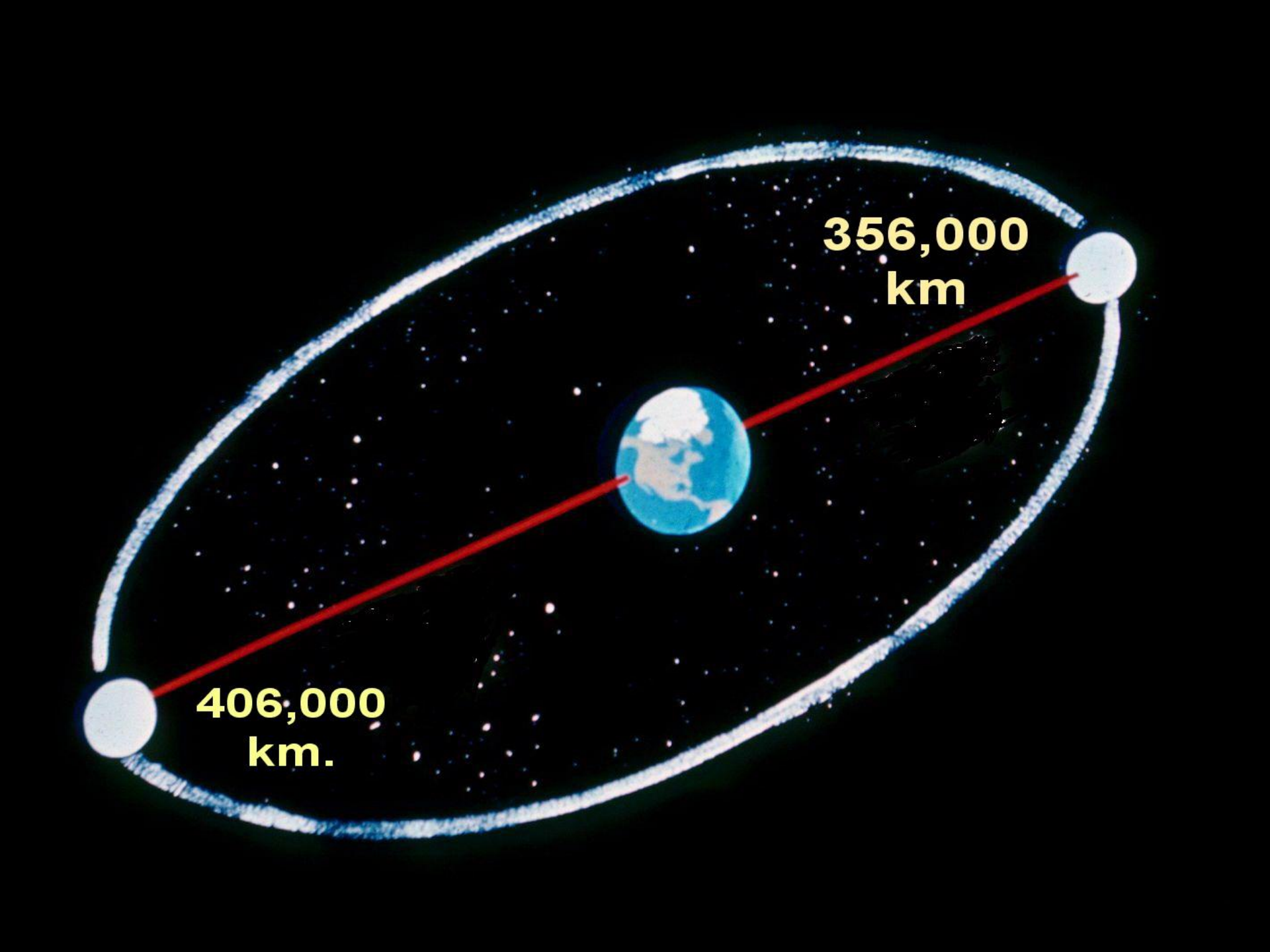
March 7, 1970 - Mexico, US, Nova Scotia
March 18, 1988 – Philippines, Indonesia
March 29, 2006 – Egypt, Libya, Turkey
April 8, 2024 - Mexico, US, Eastern Canada

Here is a summary of the concepts:

- a solar eclipse can only happen at New Moon
- tilt of Moon's orbit causes the Moon to miss the Sun at most New Moons
- solar eclipses repeat in the 'saros' cycle of 18 years, 11 days and 8 hours
- successive eclipses in a saros are shifted 1/3 of the way around the Earth, towards the West
- many saros cycles (around 45) are occurring at the same time
- we get a total eclipse somewhere on the Earth about every 18 months

Types of Solar Eclipses




356,000
km
406,000
km.


Lunar Orbit
The Earth
Path
of
Annular Eclipse
The Moon
The Sun

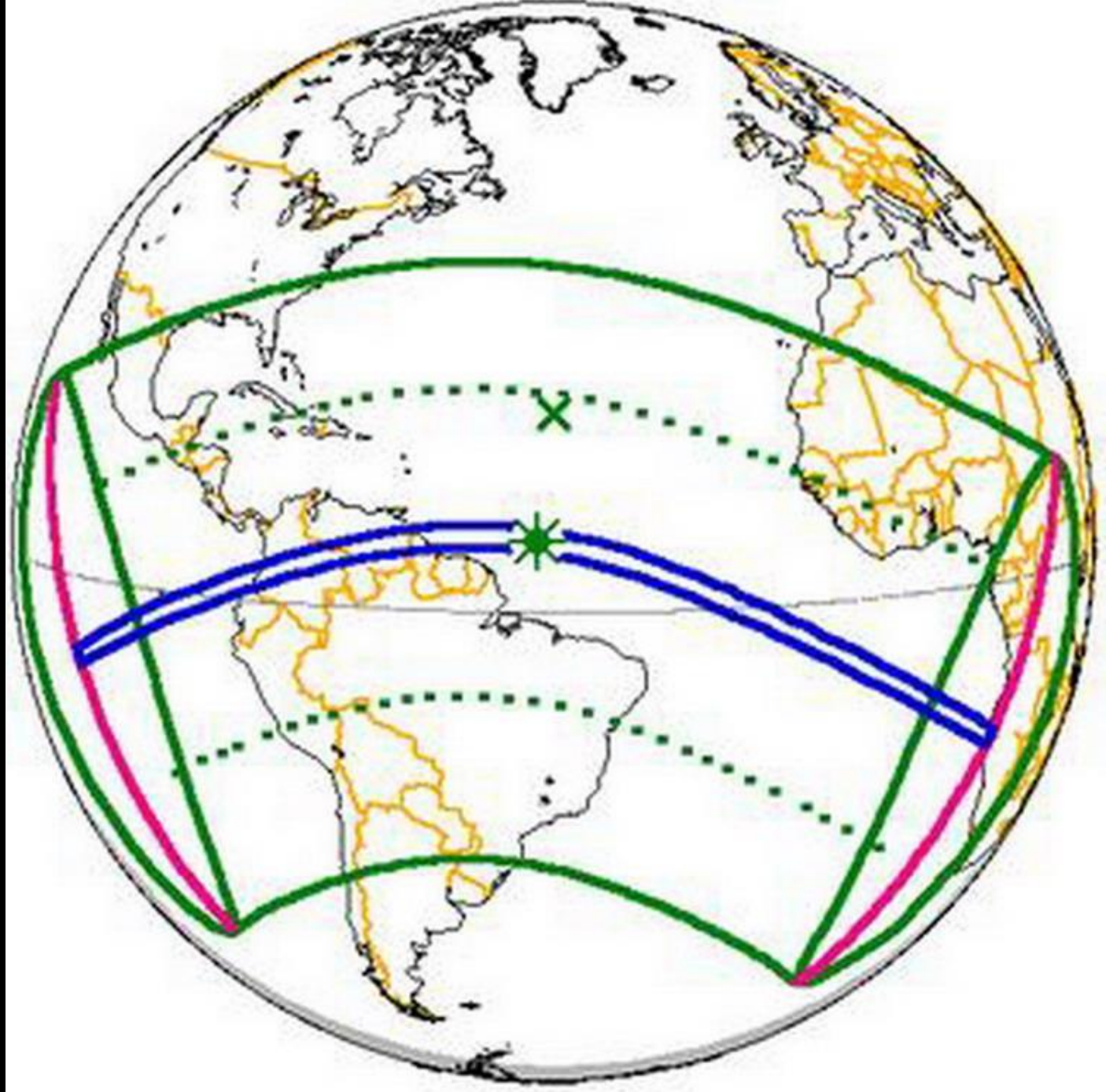
Question: What is the *longest possible* total eclipse of the sun?

Answer: 7 minutes and 31 seconds

When will we have the next VERY long total eclipse?

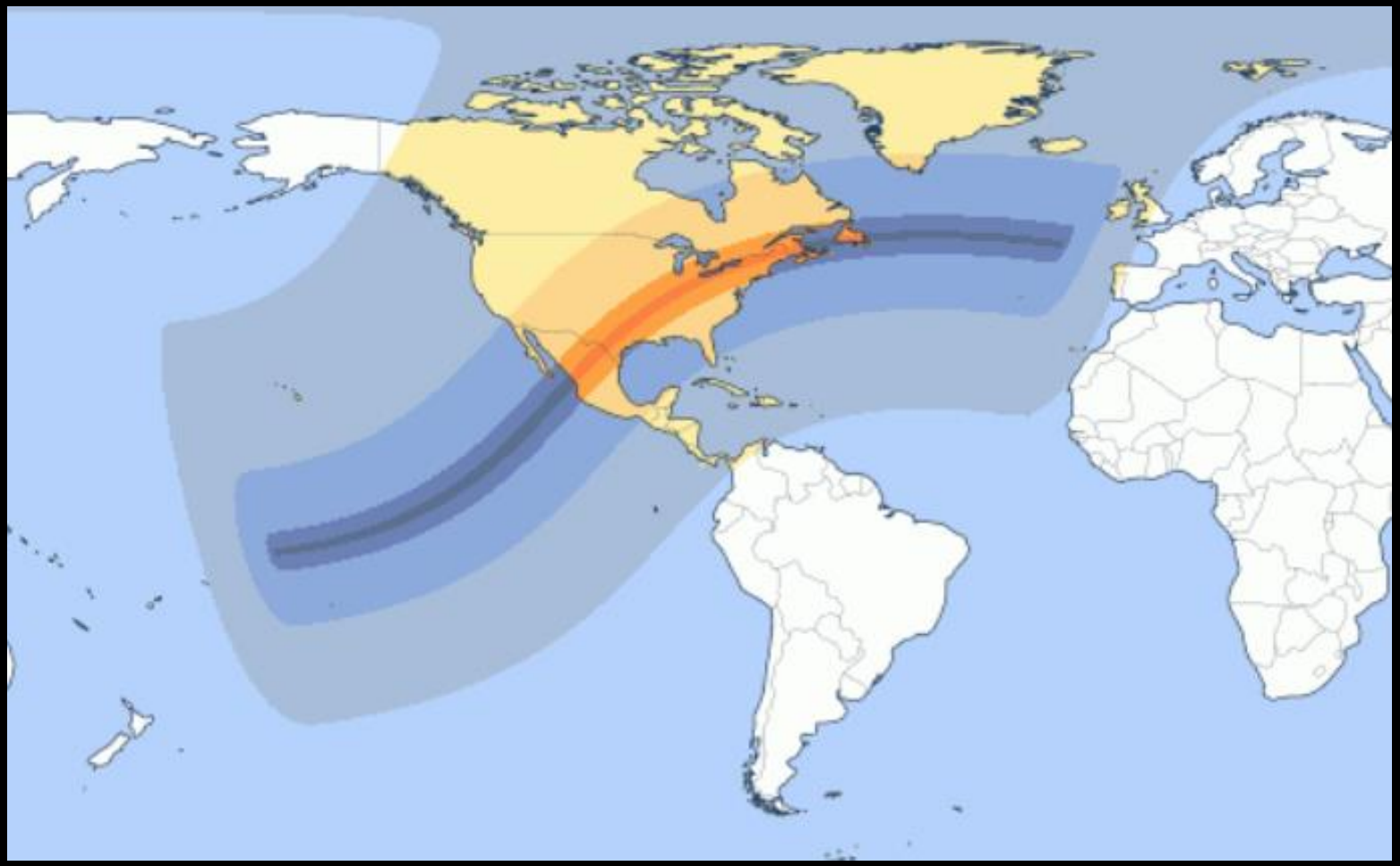
Answer: July 16, 2186 (the longest one from 6000 BC to 4000 AD)

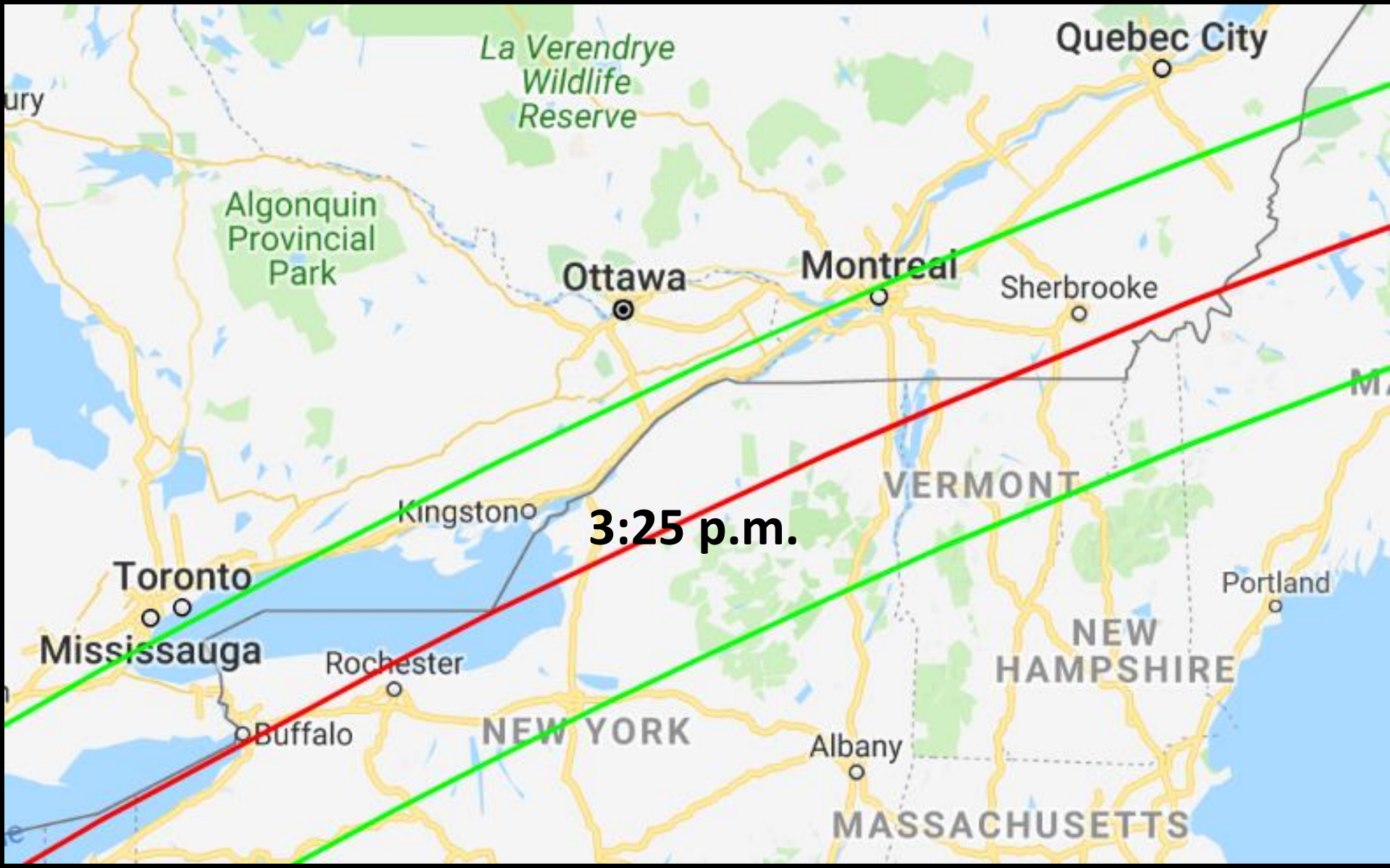
Duration of totality = 7:29

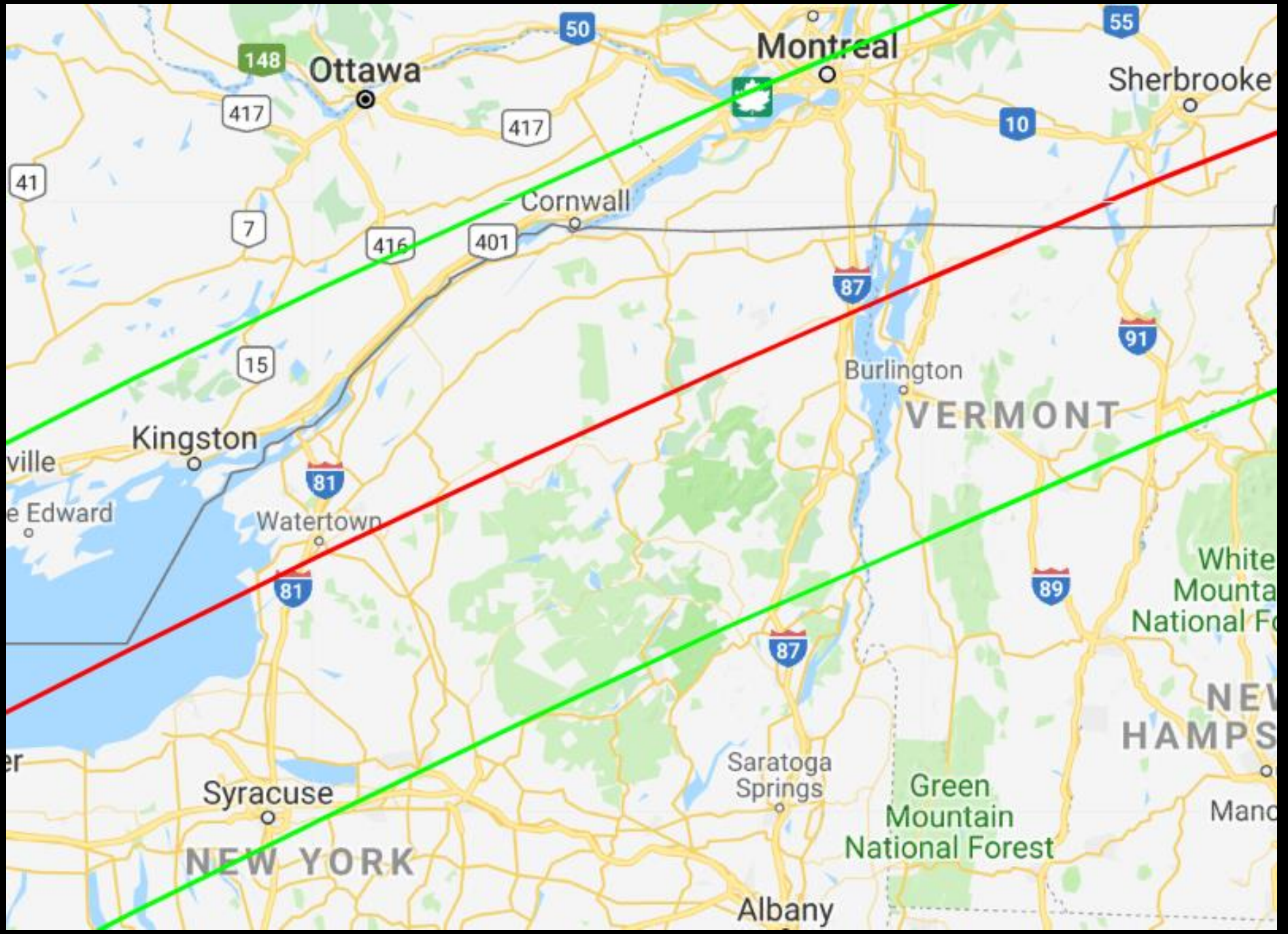


The Next Total Solar Eclipse for North America

Monday - April 8, 2024




La Verendrye Wildlife Reserve
Quebec City
Algonquin Provincial Park
Ottawa
Montreal
Sherbrooke
VERMONT
Kingstono
3:25 p.m.
Toronto
Mississauga
Portland
NEW HAMPSHIRE
Rochester
Buffalo
NEW YORK
Albany
MASSACHUSETTS


Montreal
Ottawa
Sherbrooke
Cornwall
Burlington
VERMONT
Kingston
Watertown
Syracuse
NEW YORK
Saratoga Springs
Green Mountain National Forest
Albany
50
55
148
417
417
10
41
7
416
401
87
91
15
81
81
89
87

What can you do to plan for April 8, 2024?
Totality in Eastern Ontario will occur around 3:25 p.m.

- Obtain a safe solar filter for the partial phases; **don't** wait, act early!
- Decide where you plan to be; do **NOT** stay in Ottawa - travel inside the path of totality
- Do **NOT** try to travel to the path at 1 p.m. on Eclipse Day!
- Do **NOT** try to cross the border to Upstate New York on Eclipse Day!
- Consider booking a hotel for a place inside the path for the night of April 7th
- Watch the weather websites carefully, and adjust your plans as needed
- **Mobility** is the key!

A very useful website about the eclipse

https://www.theweathernetwork.com/en/news/science/space/how-to-prepare-for-the-april-8-total-solar-eclipse-across-eastern-canada

Thank-you, OPCUG!