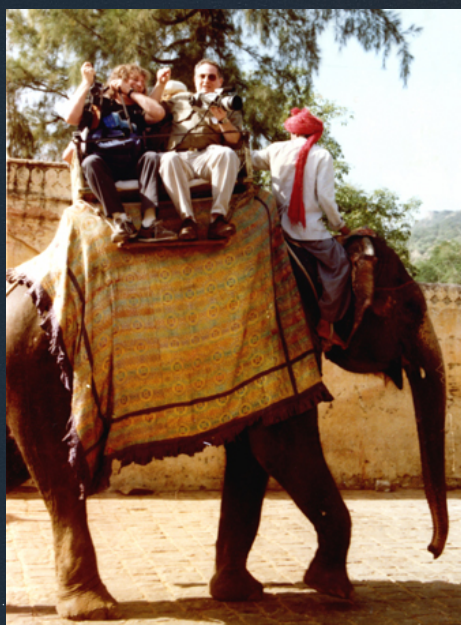




TOTAL SOLAR ECLIPSE 21 AUGUST 2017 COARC – MADRAS, OR

WARNING: Eclipse
chasing is addictive.
There is no cure.

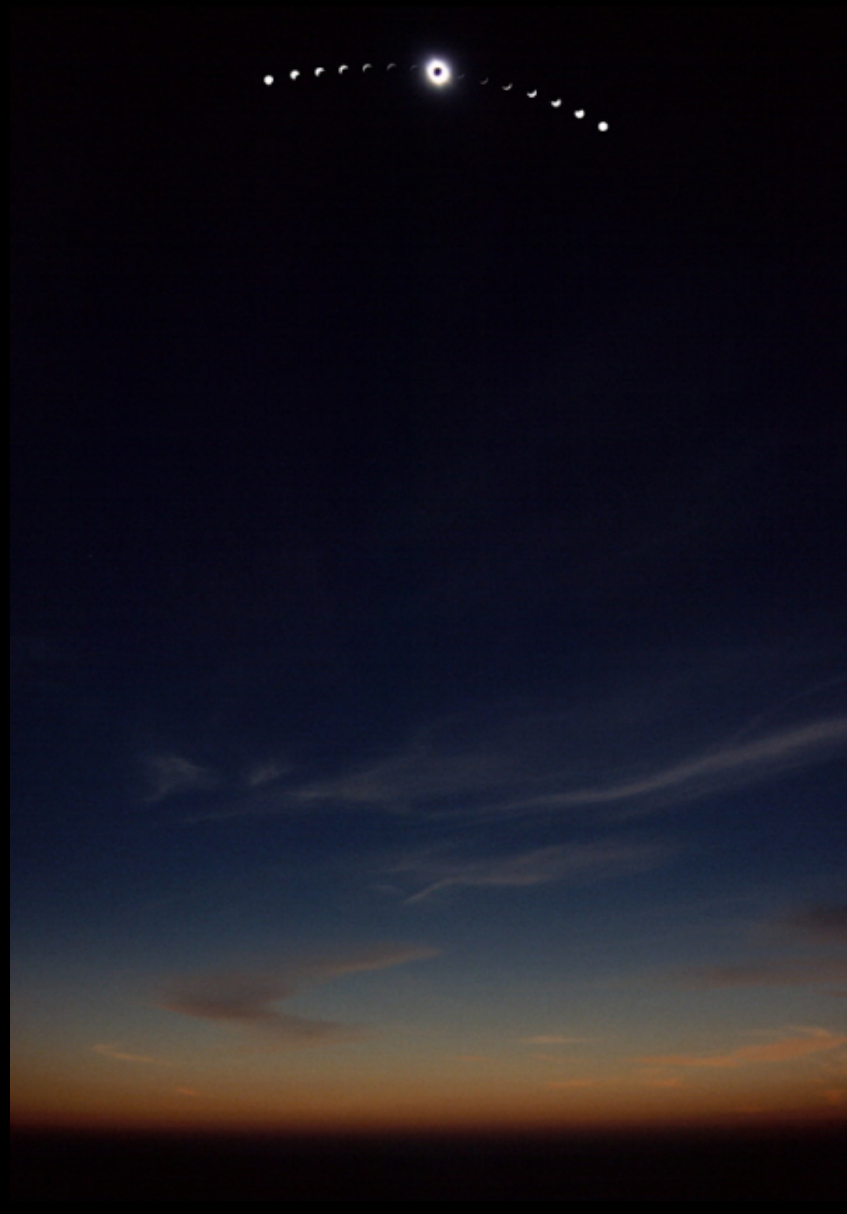
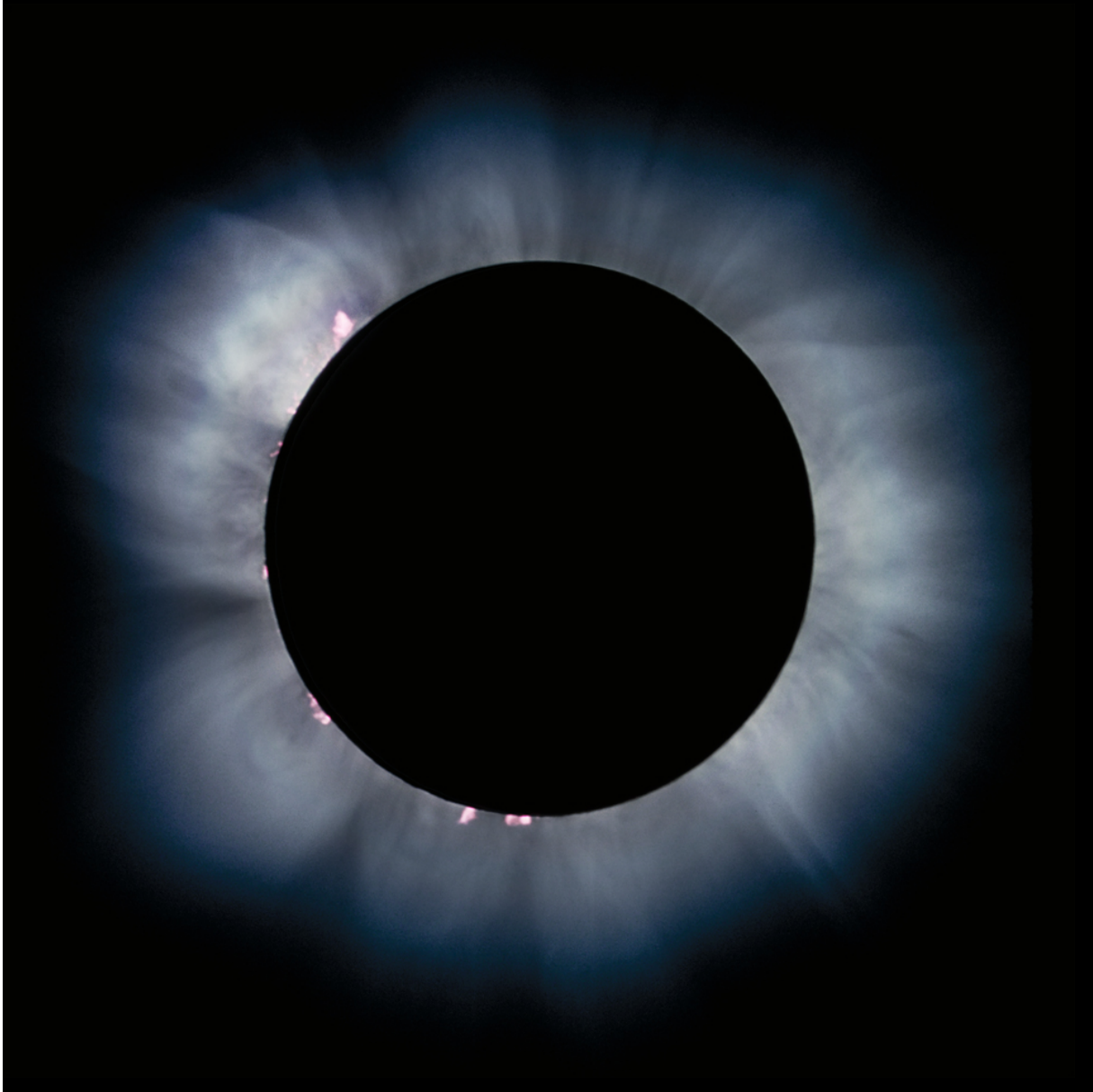


Dr. Glenn Schneider
Steward Observatory
University of Arizona
Tucson, Arizona 85721
USA



center image by M. Druckmuller

Science aside... A TOTAL Solar Eclipse is arguably *THE* most impressive and awe inspiring re-occurring natural phenomenon that humans can witness



A dramatic sky scene featuring a bright celestial body, possibly the moon, in the upper left. The sky transitions from a deep blue at the top to a bright orange and yellow near the horizon, where a sunset or sunrise is occurring. Below the horizon, a dense layer of white and grey clouds is visible. The text is overlaid in the bottom half of the image.

The MOST Viscerally Dramatic
And Dynamic of ALL Celestial
Events Humans Can Witness on Earth

Ominous Beginnings: Most Oft-Cited and Best-Known Examples

22 October 2134 B.C.

Pre-Xia dynastic ancient China
(period of 3 sovereigns & 5 emperors)

Tale of two court astrologers (Hi and Ho) who were purportedly beheaded for failing to predict a total solar eclipse.



Epitaph of Hi and Ho:

“Here lie the bodies of Ho and Hi,
Whose fate, though sad, is risible;
Being slain because they could not spy
Th' eclipse which was invisible.”

- author unknown

Ominous Beginnings: Most Oft-Cited and Best-Known Examples

28 May 585 B.C.

The Battle of Halys (Lydian/Median war).

“A battle took place in which it happened... that suddenly the day became night. And this *change of the day* Thales the Milesian had foretold to the Ionians... The Lydians however and the Medes, when they saw that it had become night instead of day, ceased from their fighting and were much more eager both of them that peace should be made between them.”

– Herodotus of Halicarnassus

Ominous Beginnings: Most Oft-Cited and Best-Known Examples

From the Book of Amos (Chapter 8):

9. And it shall come to pass in that day, saith the Lord GOD, that *I will cause the sun to go down at noon, and I will darken the earth in the clear day:*

10. And I will *turn your feasts into mourning, and all your songs into lamentation; and I will bring up sackcloth upon all loins, and baldness upon every head; and I will make it as the mourning of an only son, and the end thereof as a bitter day.*

Today we know due to the inexorable laws of Celestial Mechanics



With the moon occasionally covering up the Sun



Sometimes only partially (a partial solar eclipse)



Sometimes half covered or less....



Sometimes more deeply,



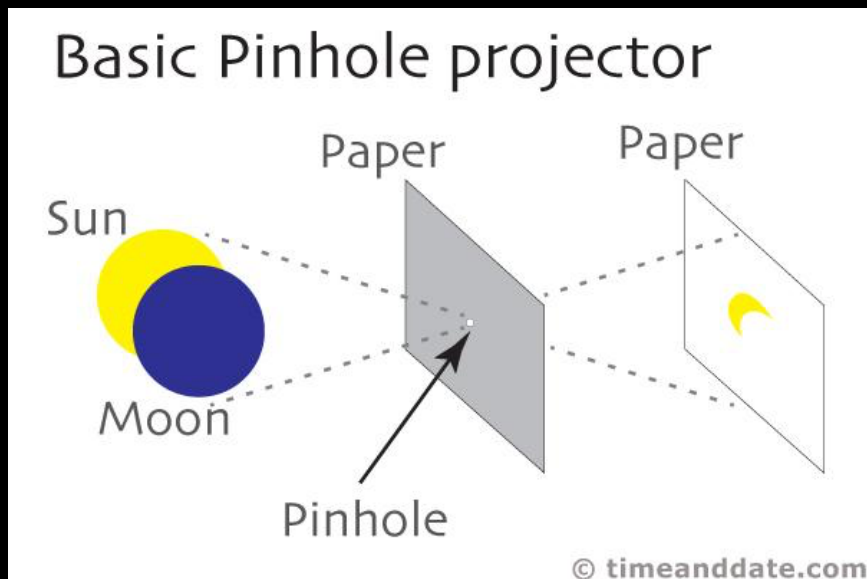
But the Sun's bright (photosphere) disk,
EVEN during a partial eclipse,
MUST ALWAYS ONLY BE OBSERVED DIRECTLY WITH...

ISO Certified SAFE Solar Viewing Shades (Glasses) or Filters



Or...

INDIRECTLY, e.g., with Pinhole Projection





BUT,
DURING TOTALITY
USE YOUR
UNFILTERED EYES!

brightness of corona
about that of the
full moon

Solar Eclipses give us an opportunity to study the Sun



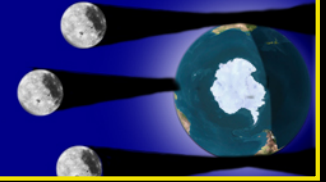
BUT, equally important to enjoy – when total – one of nature's most glorious events

THE SUN - The Nearest Star

- Distance: 93,000,000 miles (8.3 light min.; 250,000x closer than α Cen)
- Diameter: 857,000 miles (108x Earth)
- Volume: 1,260,000x Earth
- Mass: 1.99×10^{30} kg (330,000x Earth)
- “Surface” Temperature $5,700^{\circ}$ C
- Core Temperature $15,000,000^{\circ}$ C
- Core Pressure: 340,000,000,000 Earth's
Air pressure at Sea Level
- Composition: 92.1% H, 7.8% He
- Energy Generation: Nuclear Fusion
 - $\text{H} \rightarrow \text{He} + \text{energy}$ ($E = mc^2$)
 - 700 million tons H/second $\rightarrow$ He
 - 5 million tons H/second $\rightarrow$ energy
 - Earth receives 1/2,000,000,000th E(sun)
 - Earth receives 1,400 watts/meter² E(sun)
- Age: 4.6 billion years
- Lifetime: Appx. 9 billion years



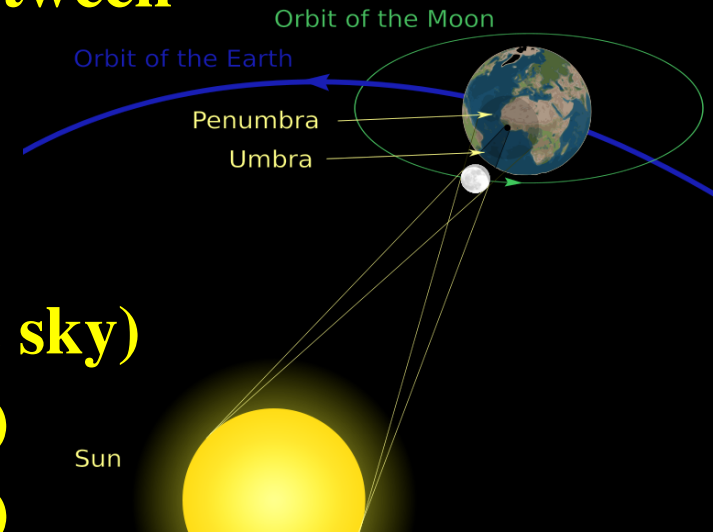
Sun



A Total Solar Eclipse (TSE)

Can occur when the Moon passes directly between the Earth and Sun, *IF* the MOON:

- 1) is “new” (i.e., “in line” with the Sun in the sky)
- 2) is close enough to Earth (orbit is elliptical)
- 3) is at a “node” (orbit is inclined to ecliptic)



THEN...

- A) The Moon's shadow will fall on the Earth
- B) The Sun's photosphere will be totally obscured at the right place, and at the right time.



COINCIDENTALLY...

- The Moon is 1/400th the diameter of the Sun*
- The Sun is 400x further away than the Moon*

So, They APPEAR the about the same size in the sky: $1/2^\circ$



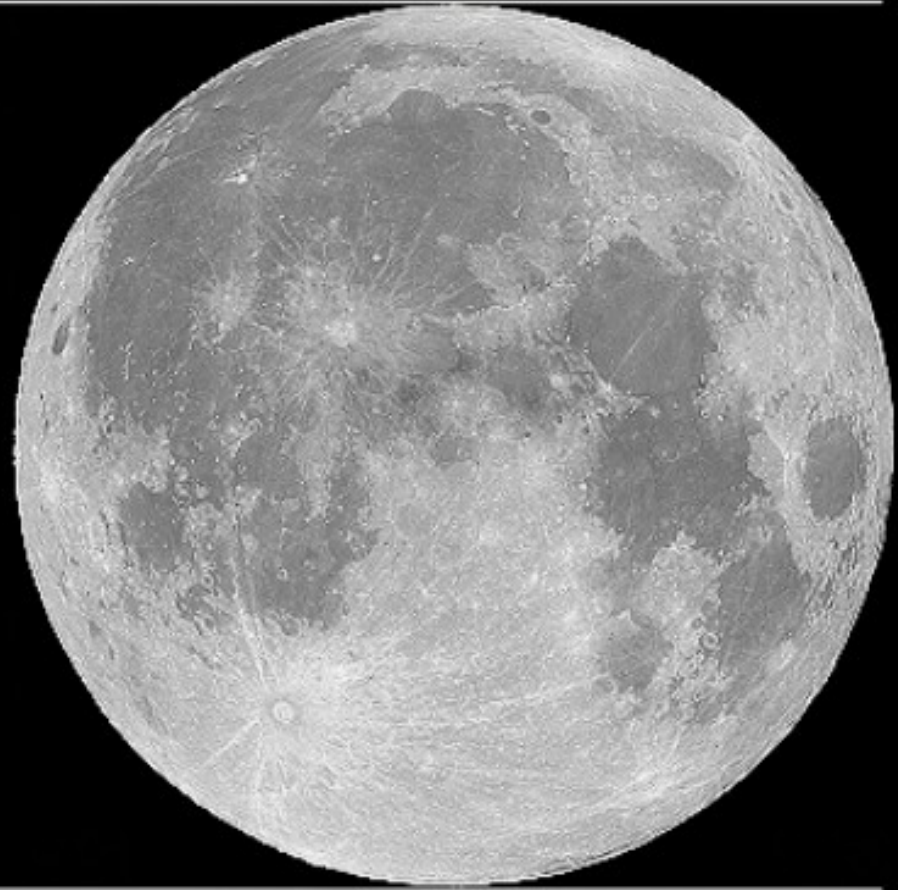
BUT... The Moon's Orbit is Elliptical, so...

Apogee



2006-02-13
405,978 km
29.87 arc-mins
Altitude @ 69.17°

Perigee



2006-09-08
357,210 km
33.89 arc-mins
Altitude @ 45.36°

So can give rise to either:

ANNULAR ECLIPSE



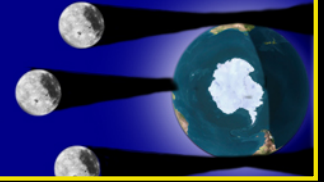
TOTAL SOLAR ECLIPSE



*The Moon's Shadow cast on the Earth
During a Total Solar Eclipse*



Sun



A Total Solar Eclipse (TSE)

Is visible only within the thin track of the Moon's shadow.

***On average* the Moon's umbral shadow:**

1) covers $\ll 1\%$ of the Earth's surface.

2) will fall somewhere on the earth once every 16 months,

BUT...

3) at any location will pass over once in 360 years

**4) will pass over a centrally located observer in about 3 minutes
on average, maximum ever 7.5 minutes**

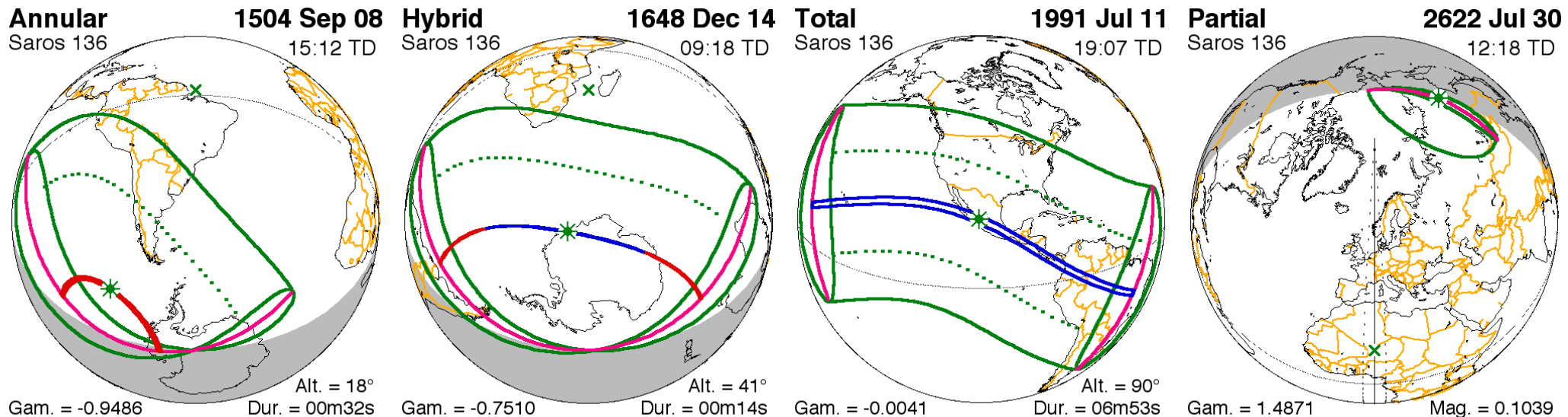
ECLIPSES re-occur in “Families”:

The Solar Eclipse SAROS Cycle

Cadence: 18 years 11 & 1/3 days

Duration: ~ 1300 years

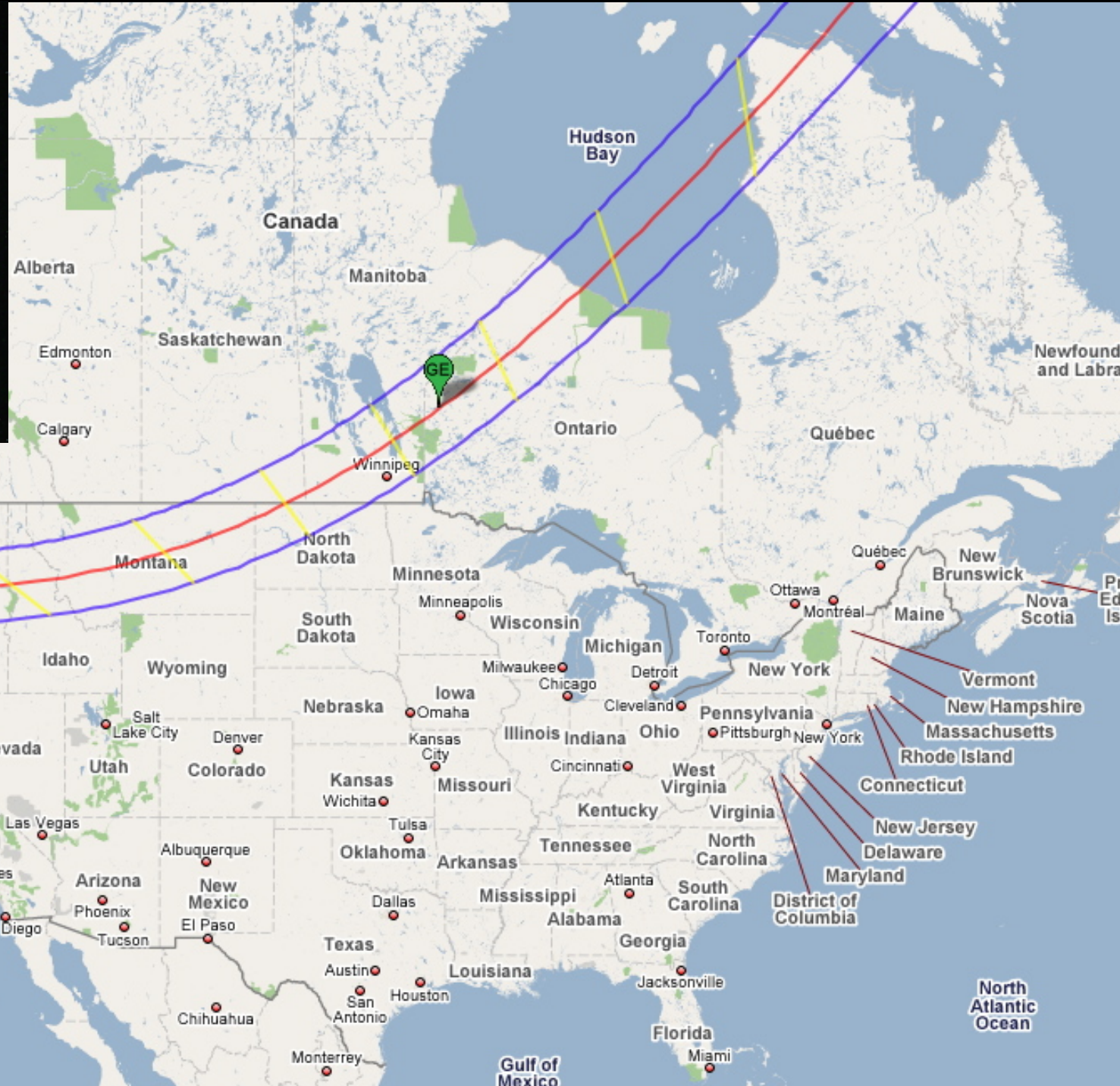
of Eclipses: ~ 72



**But... multiple overlapping cycles are running at the same times,
so eclipses occur more frequently**

29 February 1979

The last TSE visible from the Continental USA



And COARC
was right on
the southern
limit

TSE 29 February 1979

southern limit

U.S. Hwy 26

NW Boise Dr

NW Briar Ln

NW Pacific Dr

Oregon Solartown
Campground

NW Dogwood Ln

NW Dogwood Ln

NW Dogwood Ln

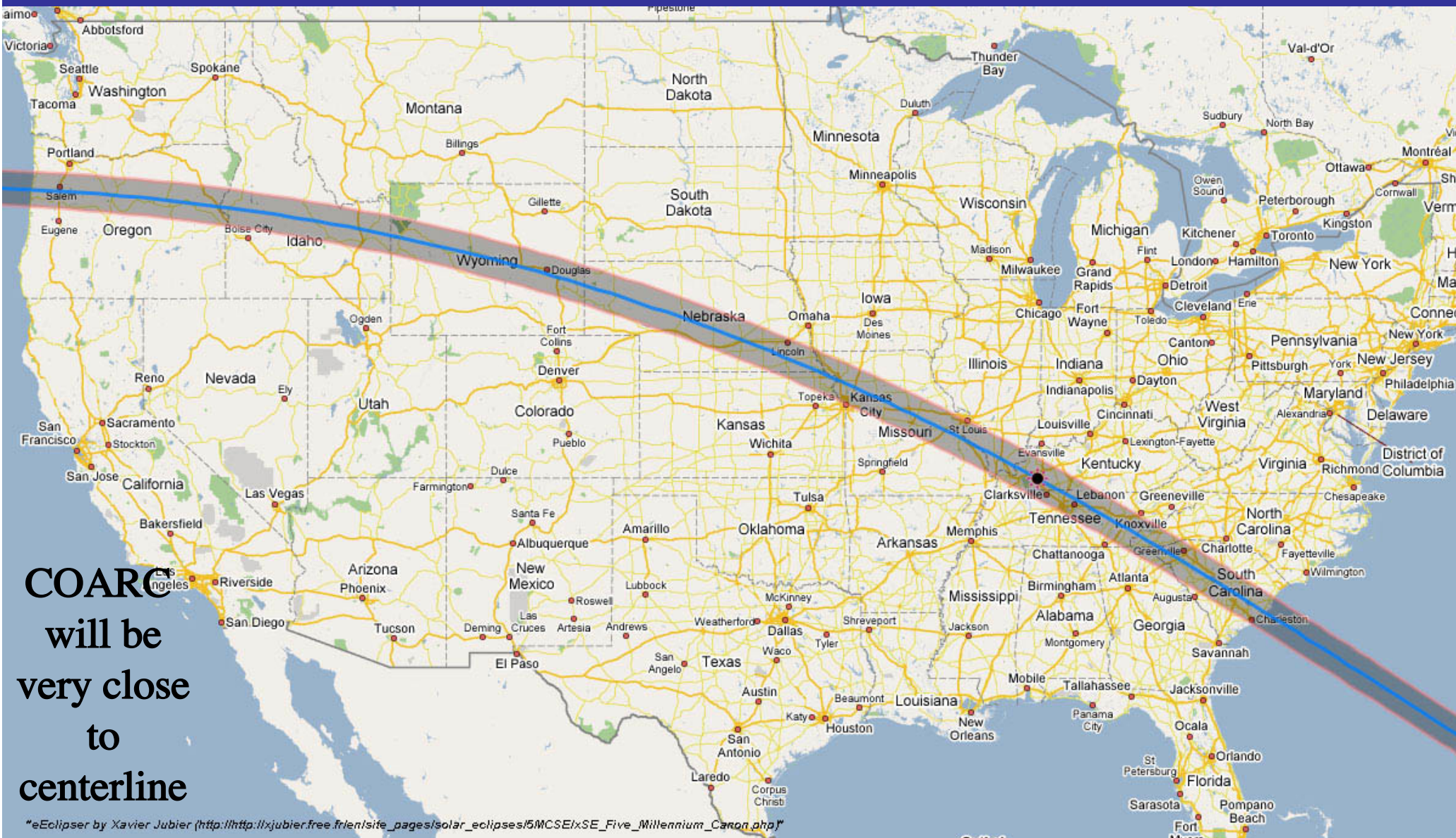
Agricultural
Research Center

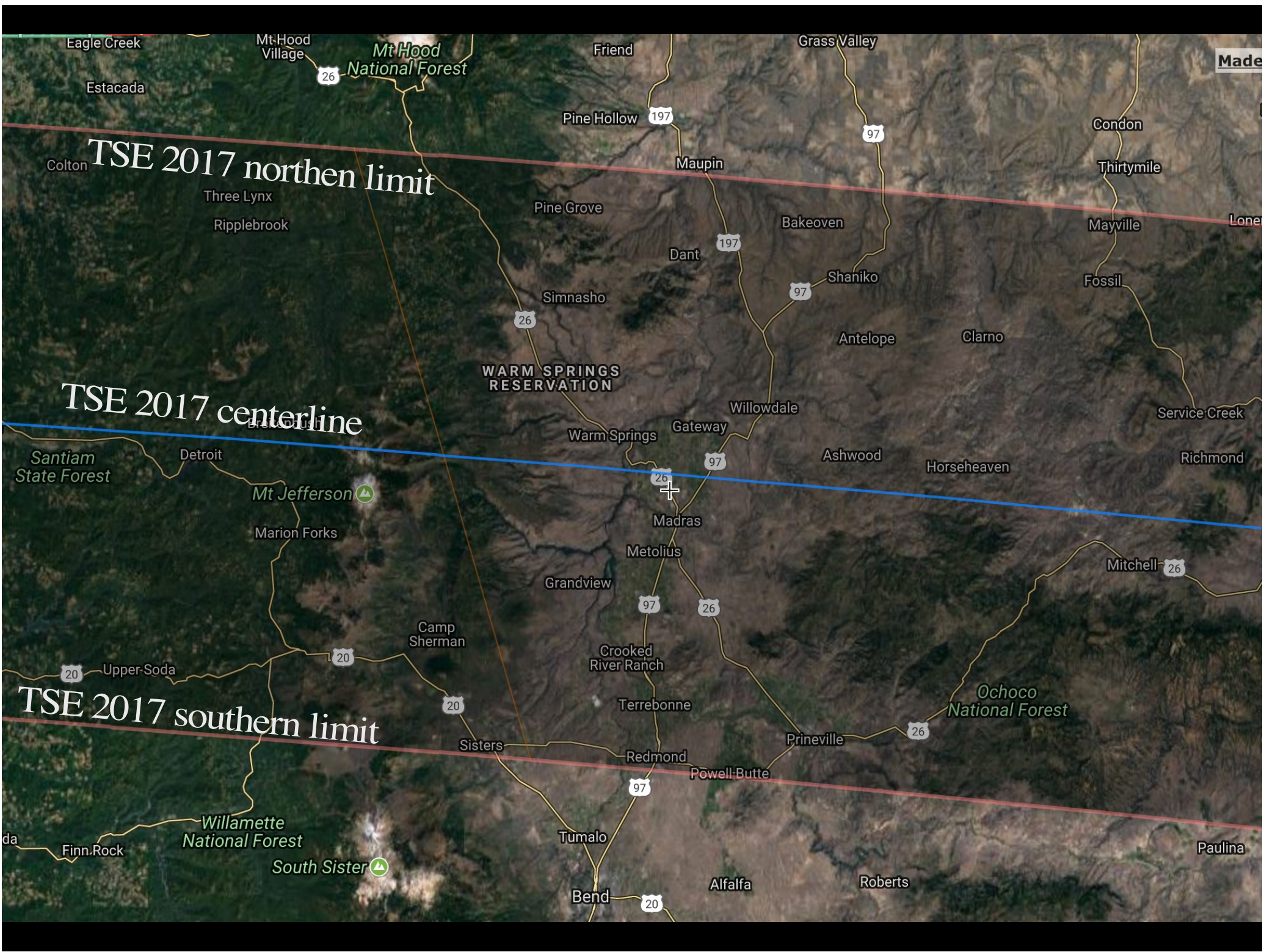
NW Dogwood Ln

NW Dogwood Ln

NW Warm Springs Hwy

Monday, August 21, 2017





TSE 2017 northern limit

TSE 2017 centerline

TSE 2017 southern limit

44° 40' 50.99" N <—> 44.68083°
121° 08' 57.53" W <—> -121.14931°
-1.0m (-3ft)

2m 03.2s (total solar eclipse)
2m 04.6s (lunar limb corrected)

[Help](#)

Umbral depth : 94.70%

2.7km (1.7mi)

Path width : 100.7km (62.6mi)

Obscuration : 100.00%



Magnitude at maximum : 1.01275

Moon/Sun size ratio : 1.02694

Umbral vel. : 1.010km/s (2260 mph)

Event ($\Delta T=68.8s$)	Date	Time (UT)	Alt	Azi	P	V	LC
Start of partial eclipse (C1) :	2017/08/21	16:06:44.7	+29.4°	102.9°	285°	13.0	
Start of total eclipse (C2) :	2017/08/21	17:19:35.0	+41.4°	119.1°	109°	07.0	-0.8s
Maximum eclipse (MAX) :	2017/08/21	17:20:36.5	+41.6°	119.4°	016°	10.2	
End of total eclipse (C3) :	2017/08/21	17:21:38.2	+41.7°	119.6°	283°	01.3	+0.6s
End of partial eclipse (C4) :	2017/08/21	18:41:03.1	+52.3°	143.8°	108°	07.6	

MAXIMUM ECLIPSE: 10:20:37 AM PDT / DURATION 2m 5s

Solar Eclipse Phenomenae

Anatomy of a Total Solar Eclipse

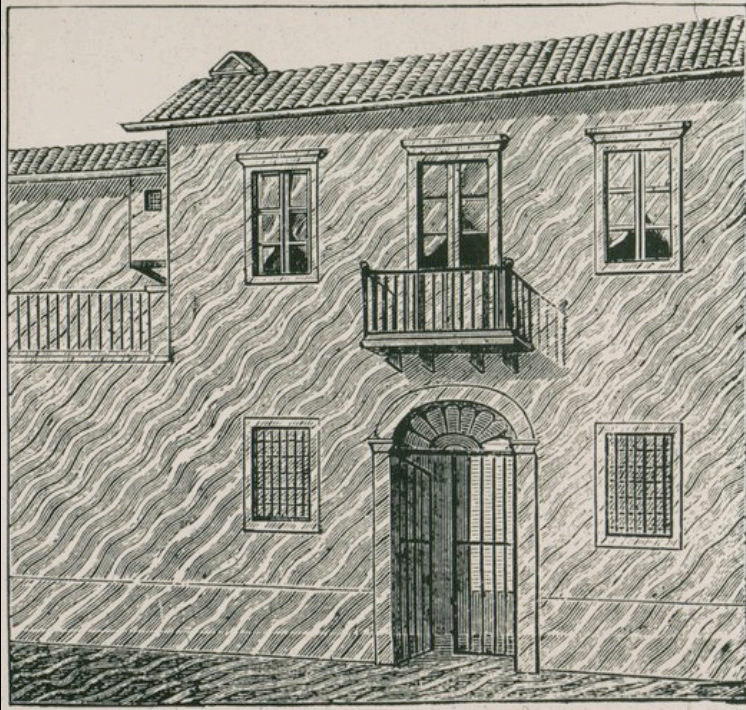


- Sky Color
- Shadow Bands
- Shadow Approach
- Sky Darkening (stars/planets)
- Bailey's Beads
- Diamond Ring
- Chromosphere
- Prominences
- Corona
- Shadow effects
sky/air/ground
- Climatic Effects

Shadow Bands



December 22, 1870



June 21, 2001



At this time, also:

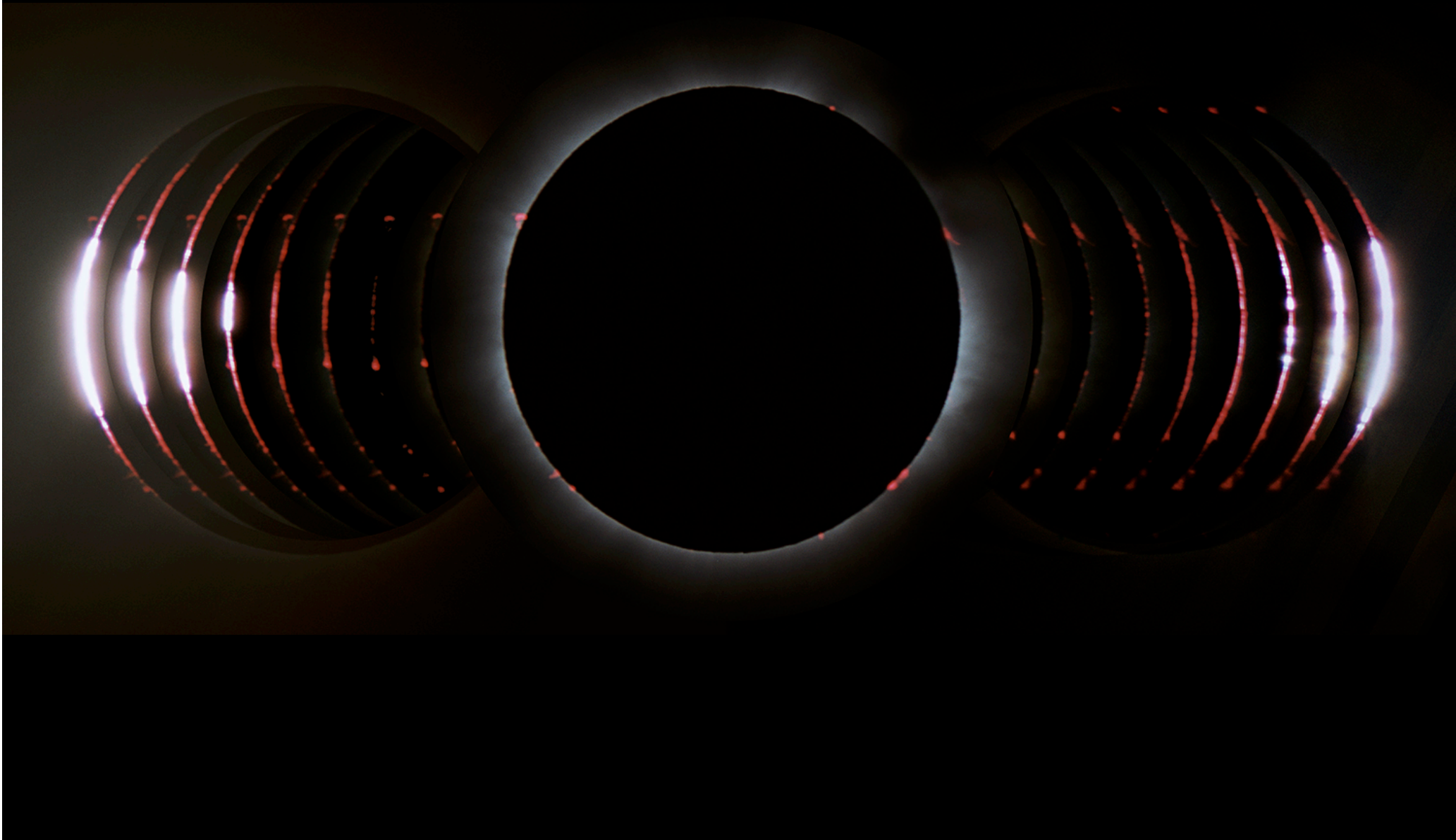
- shadows cast will get very sharp
- sky coloration is shifting shifted
- sky is rapidly darkening
- planets and brightest stars may become visible

The Moon's Shadow Approaches (TSE 2015)



Transition to(/from) Totality

photospheric arc → Baily's beads → chromosphere → inner corona



The Moon's Shadow Approaches (TSE 2015)

Chromospheric Light



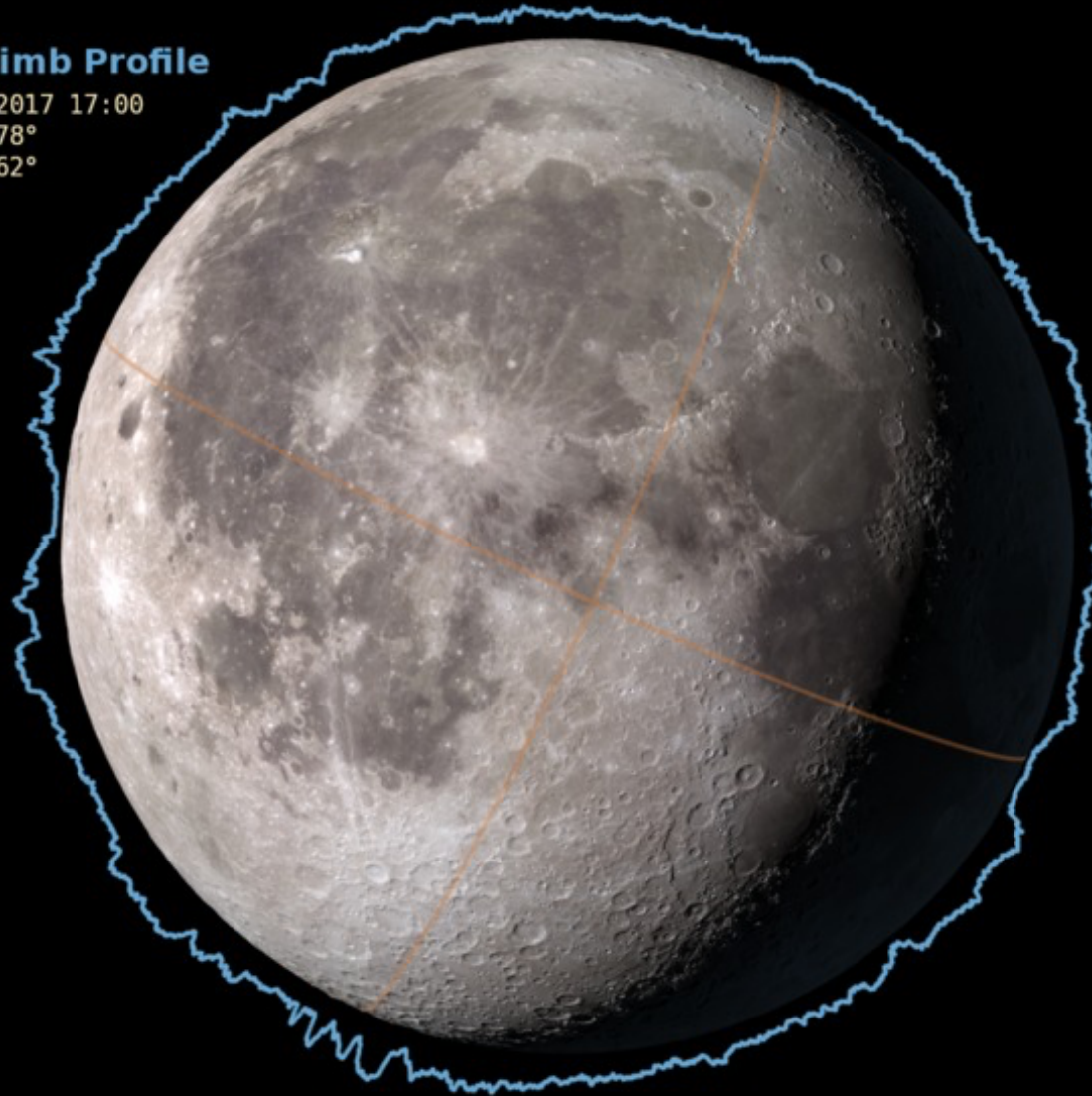
Lunar Limb Profile

LRO Limb Profile

11 Aug 2017 17:00

L: -5.278°

B: 4.562°



Vertical (radial) scale exaggerated x2000

Bailey's Beads



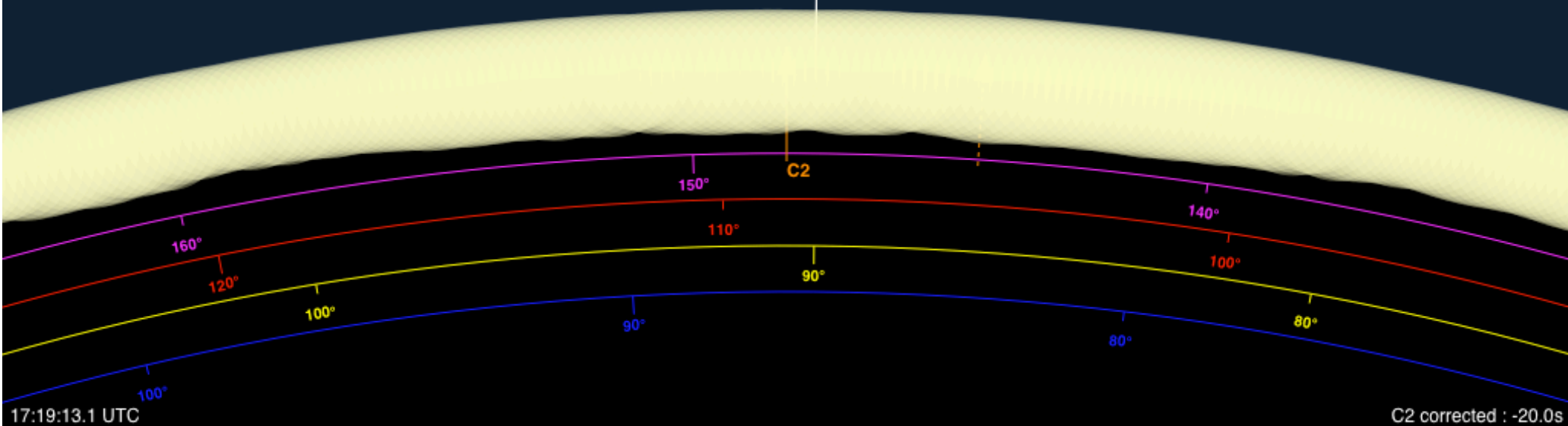
Baily's Beds & Second Contact from COARC

Loc.: MADRAS-COARC
Lat.: 44°40.837'N
Lon.: 121°08.990'W
Elv.: 740.2m

Total Solar Eclipse of 2017 Aug 21

Lunar Height Exaggeration Factor: 2x
Current magnitude: 0.9955

Topocentric Libration:
l: 5.24°
b: -0.14°
c: 21.87°



Click graphic to play...

Diamond Ring



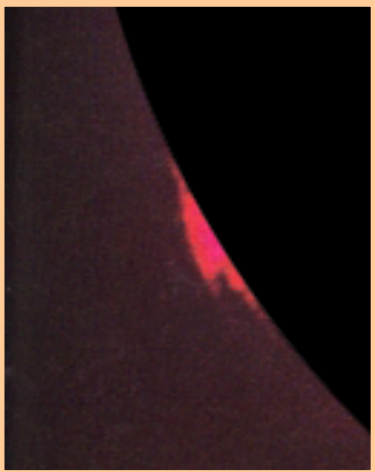
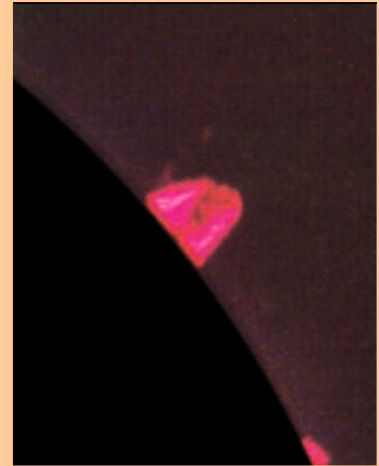
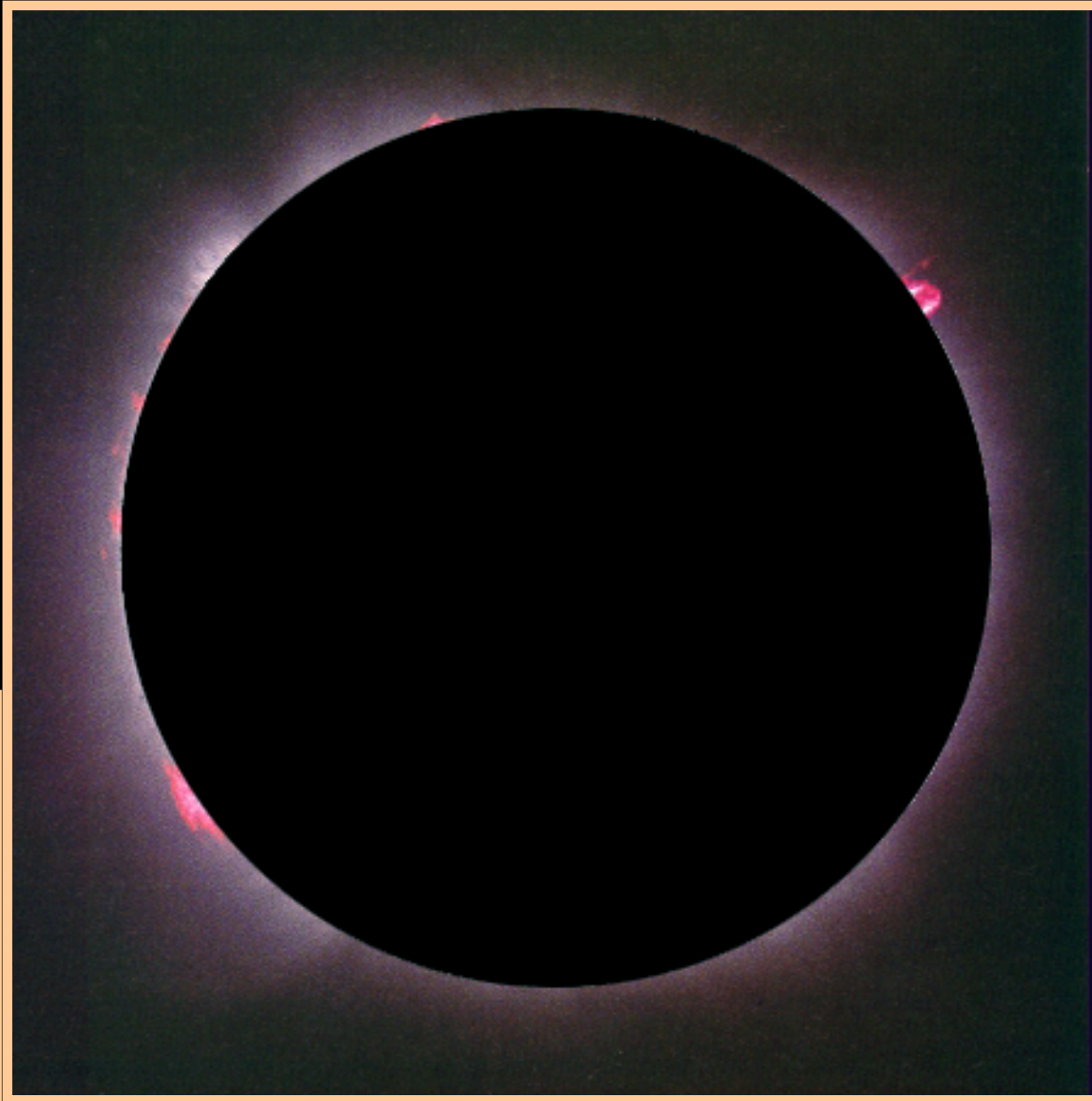
Second Contact



Chromosphere



Prominences & Inner Corona



Corona

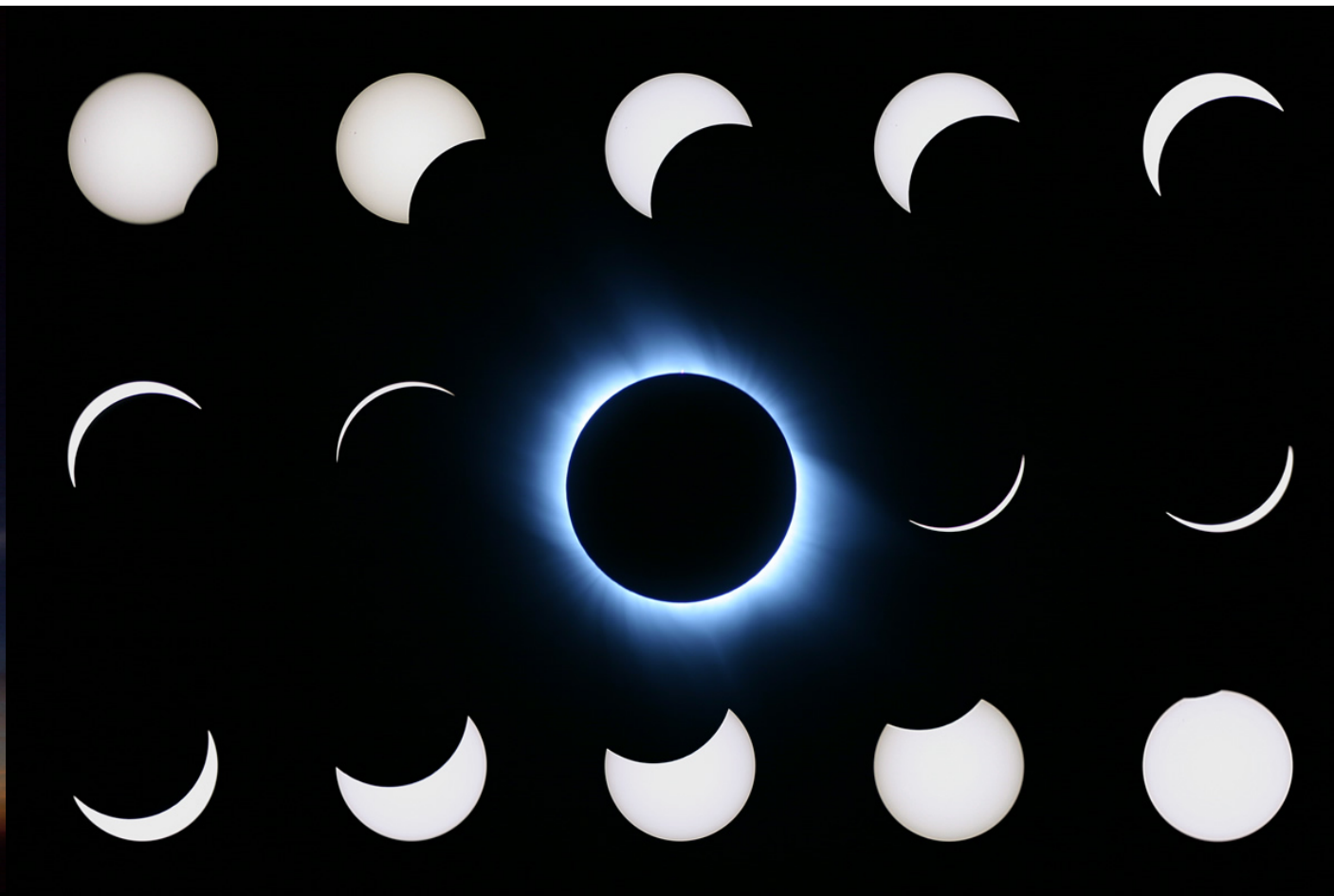
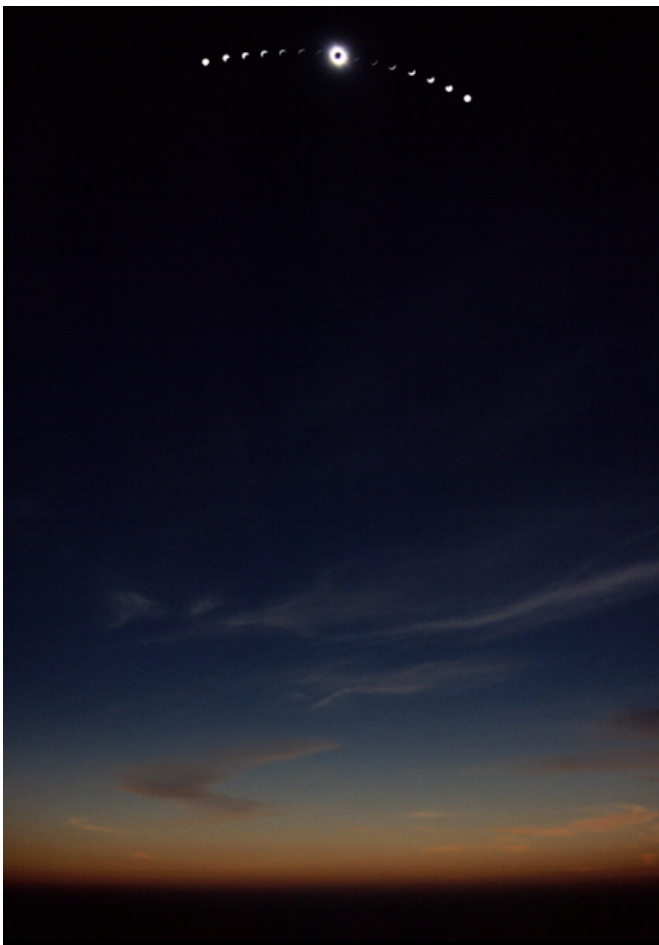


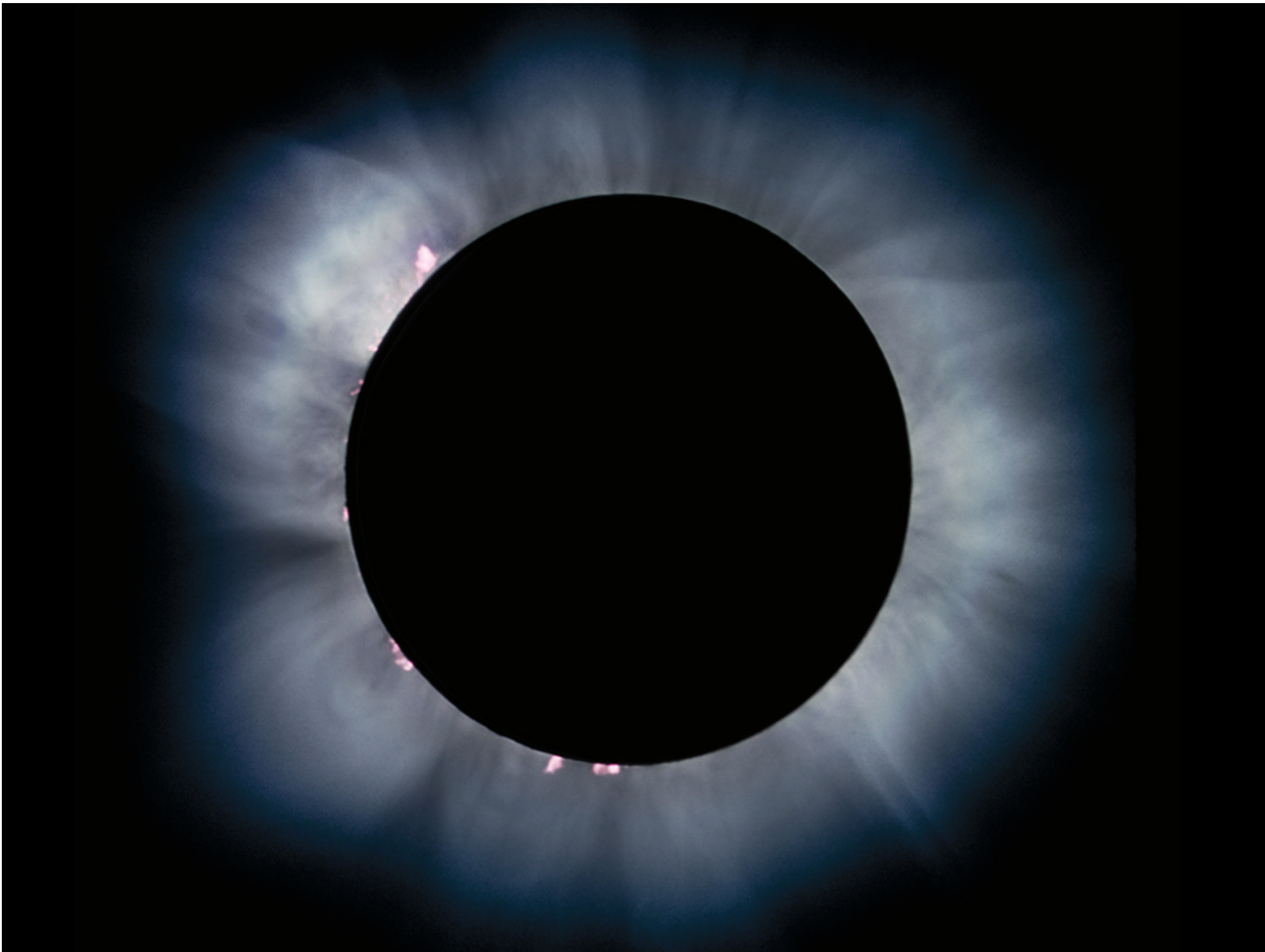
Corona



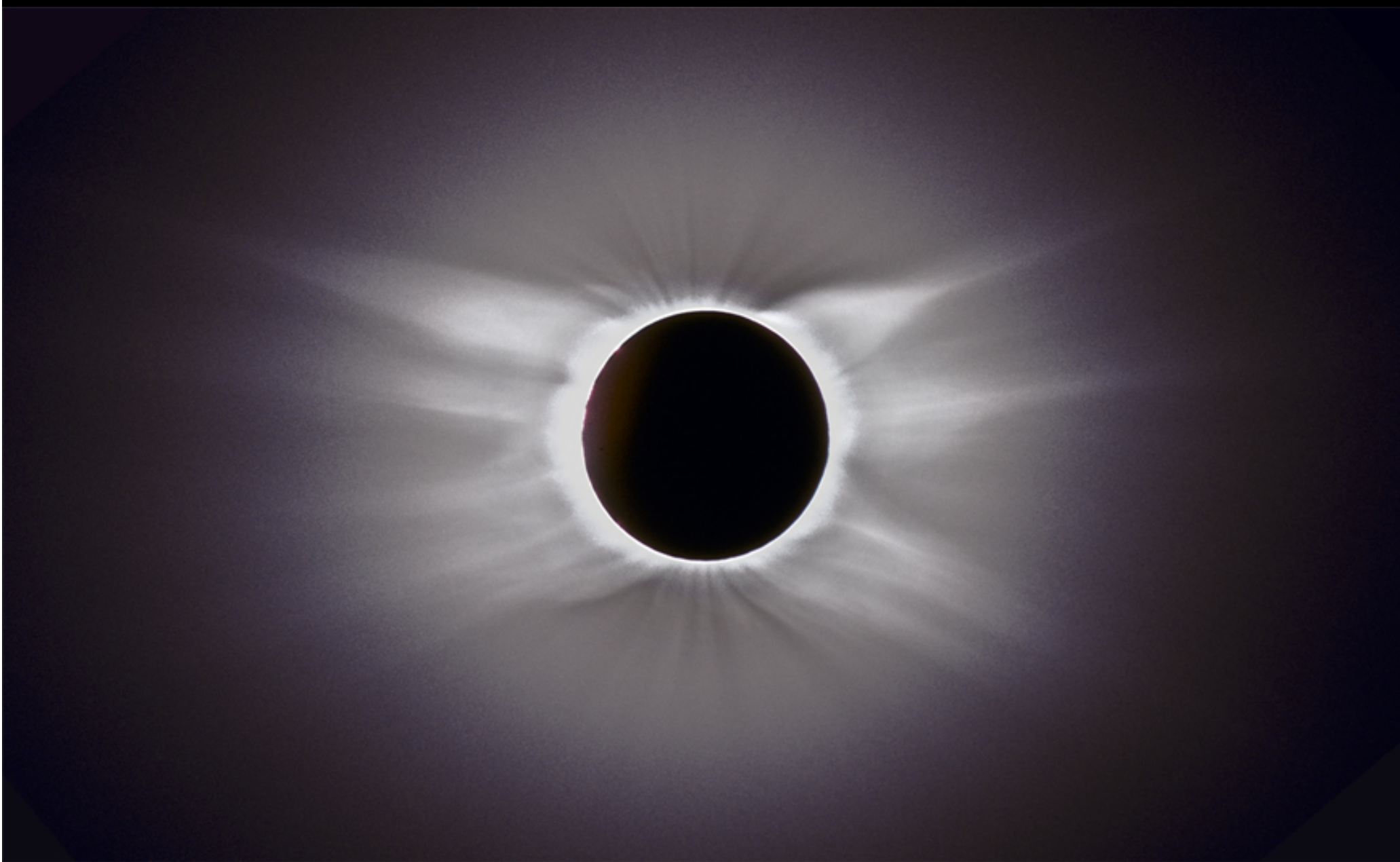
Corona







OUTER CORONA







Date : August 21, 2017
Time : 17:20:35.5 UTC
Lat. : 44.68062°N
Lon. : 121.14983°

Orientation : North Up

The SKY from COARC at Totality

PLANETS

MARS

MERCURY

VENUS

Bright STARS

Sirius

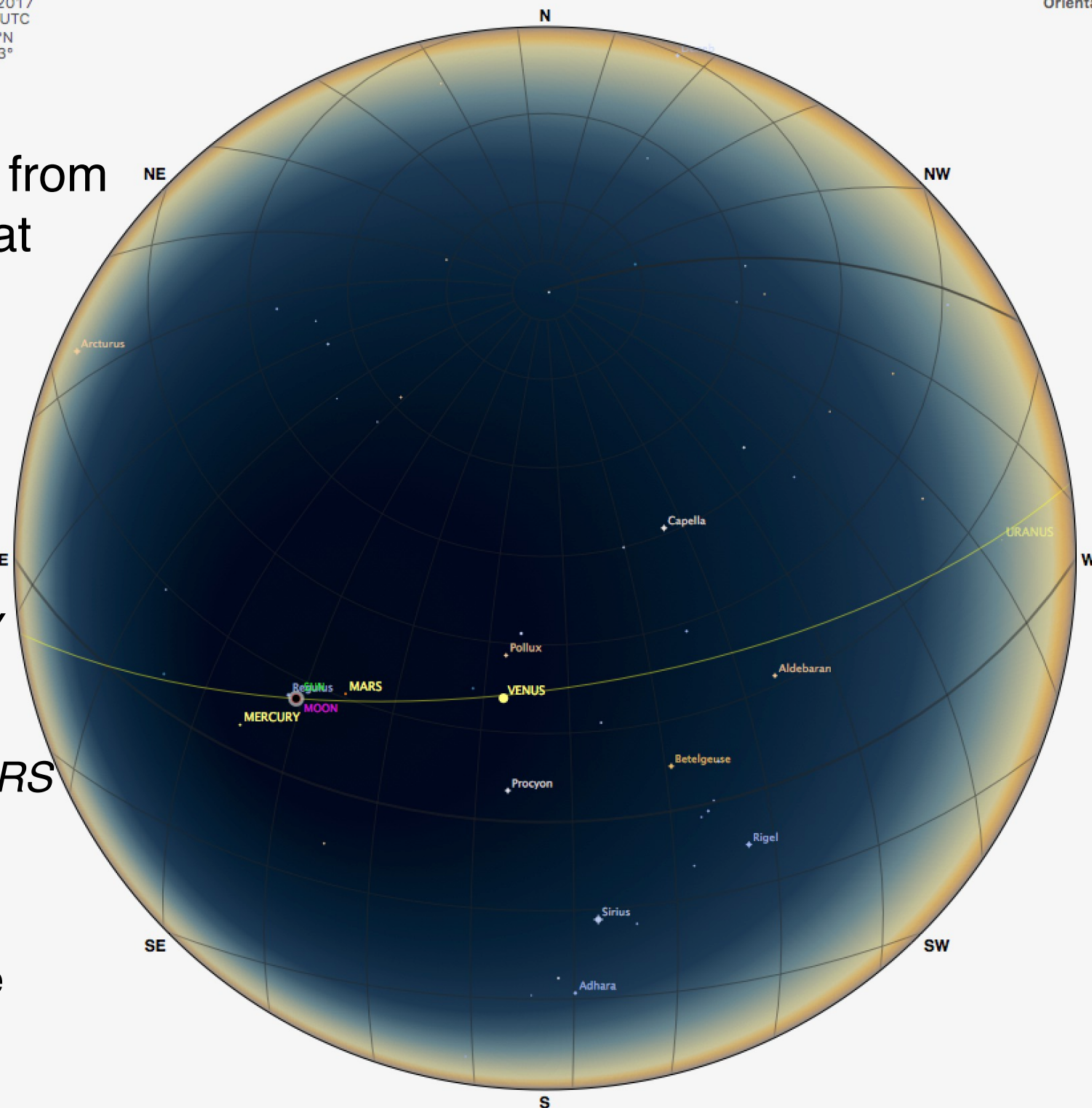
Procyon

Pollux

Betelgeuse

Rigel

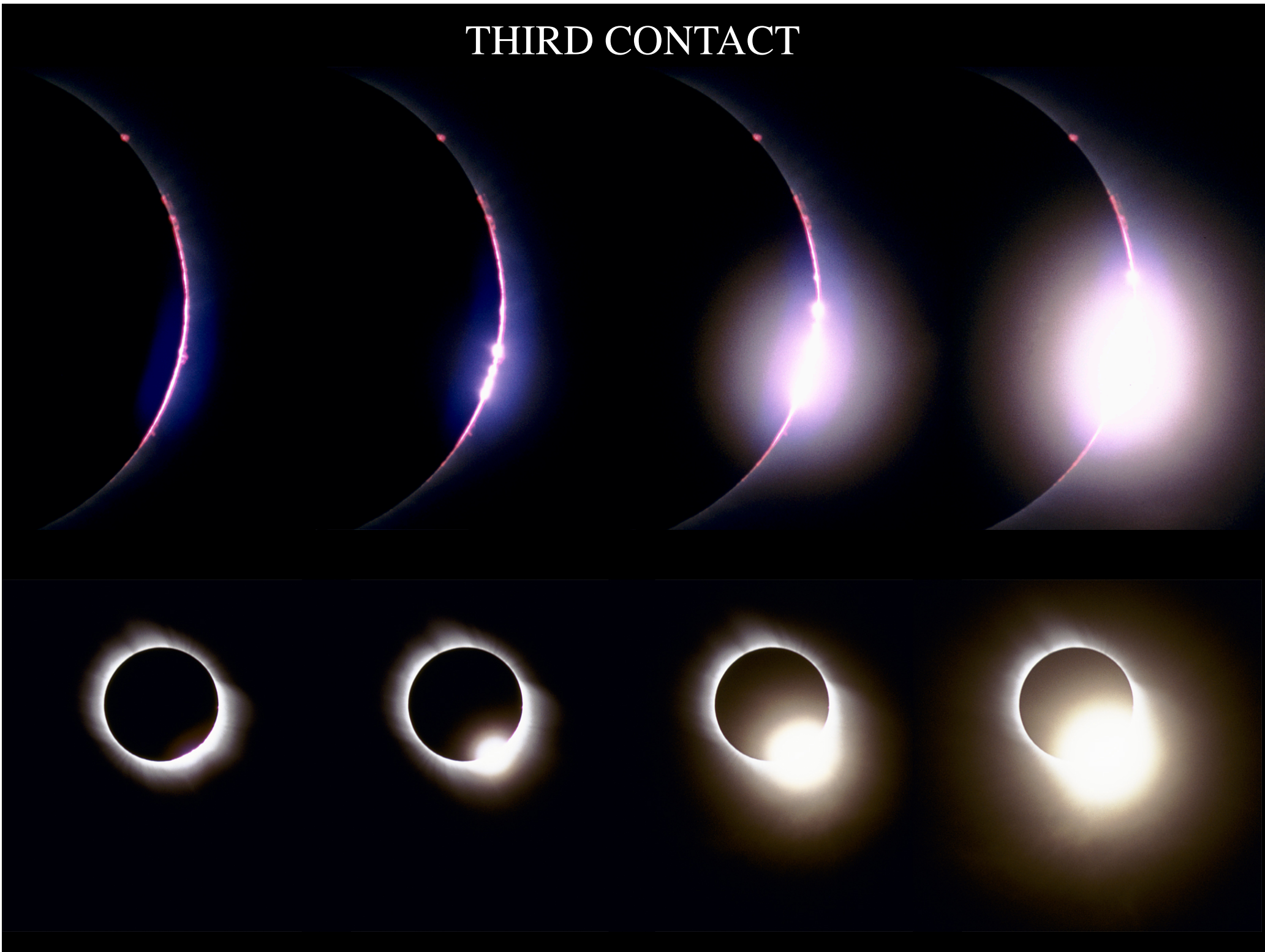
Capella



and... after 2 m 04s...



THIRD CONTACT



Saying “goodbye” to the New Moon during Partial Egress Phase...



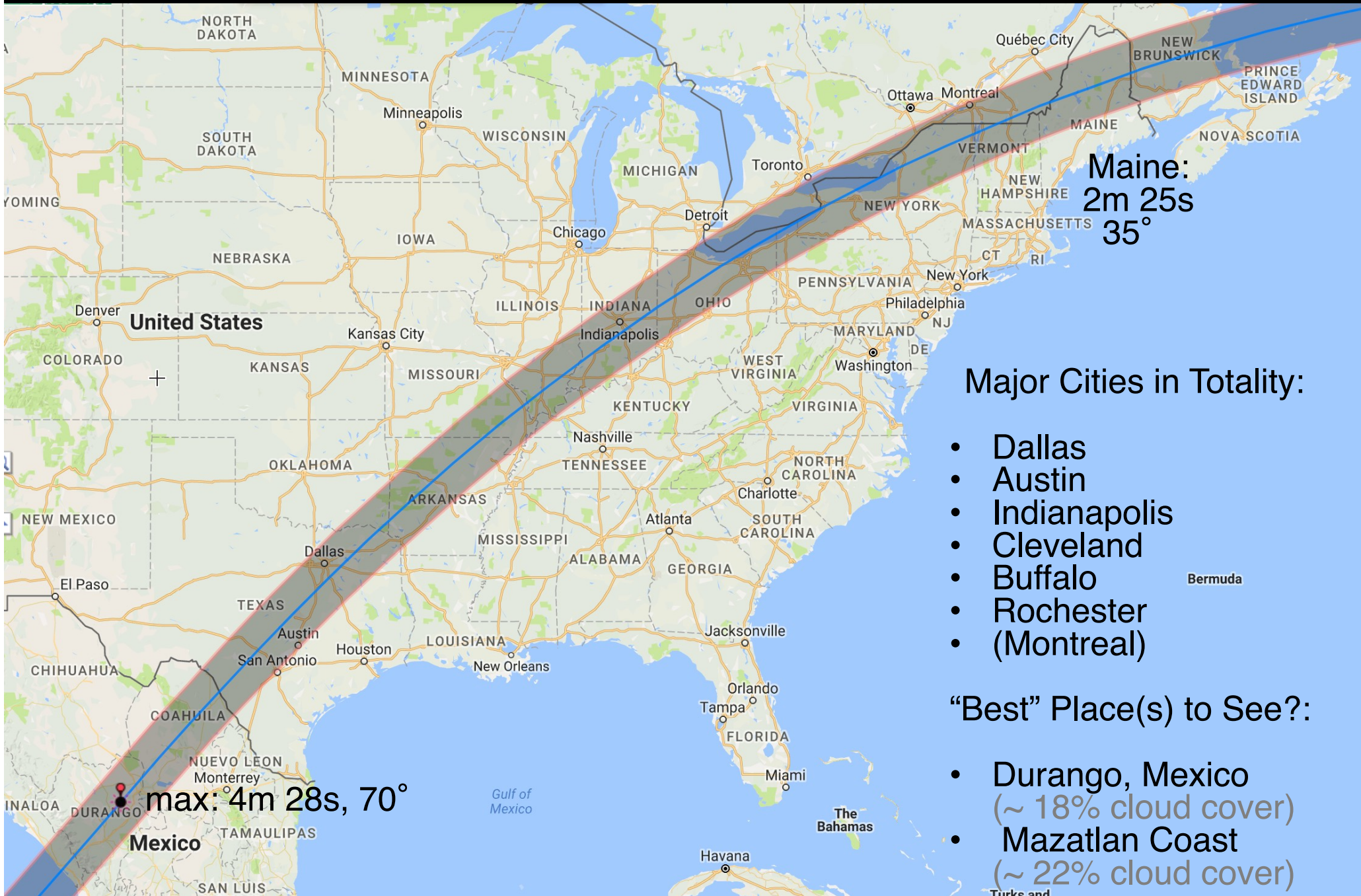
WHEN'S THE NEXT ONE?

Only 681 days from today!



JULY 2, 2019

WHEN'S THE NEXT ONE IN THE USA?

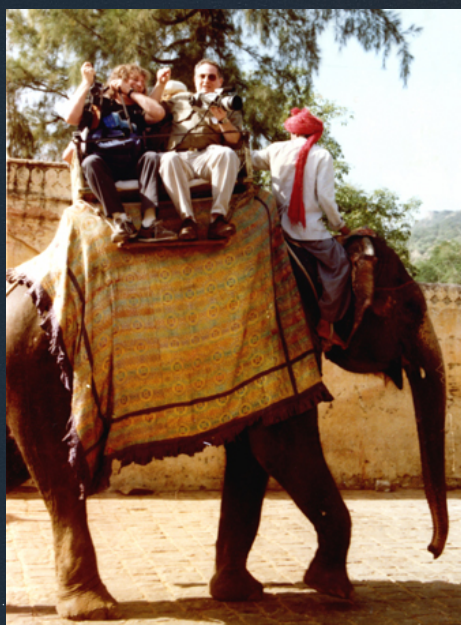


APRIL 8, 2024



TOTAL SOLAR ECLIPSE 21 AUGUST 2017 COARC – MADRAS, OR

WARNING: Eclipse
chasing is addictive.
There is no cure.



Dr. Glenn Schneider
Steward Observatory
University of Arizona
Tucson, Arizona 85721
USA



center image by M. Druckmuller