Saros and Inex

By Mike Frost

Total eclipse

The Moon's umbral shadow reaches as far as the Earth. The umbral shadow will be tiny compared to the size of the Earth, and averages 150 km in diameter. Outside the umbra a partial eclipse is visible over typically one third of the Earth's daylit surface.

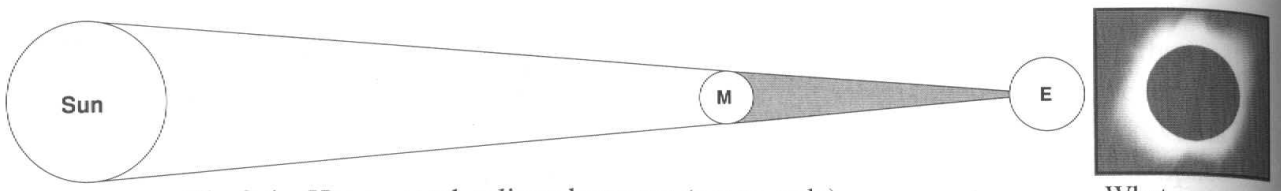


Fig 2.4 - How a total eclipse happens (not to scale)

What you see

Annular eclipse

Here the umbral shadow does not reach the Earth's surface, and the Moon is too small to obscure the Sun completely. Locations not immediately behind the the umbra will observe a partial eclipse covering one third of the Earth's daylit surface.

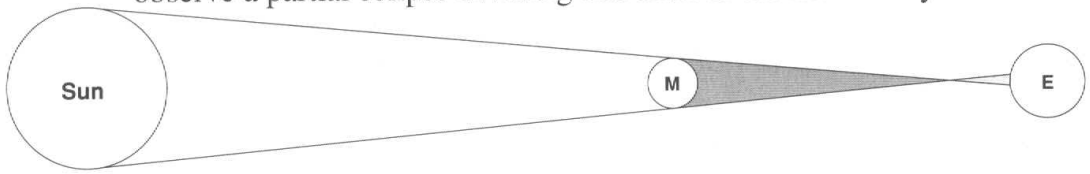


Fig 2.5 - How an annular eclipse happens (not to scale)

What you see

Partial eclipse

Here the Moon's umbra misses the Earth completely, and all you see is the Sun partially covered by the Moon. A partial eclipse is visible over a wide area, typically one third of the daylit surface of the Earth.

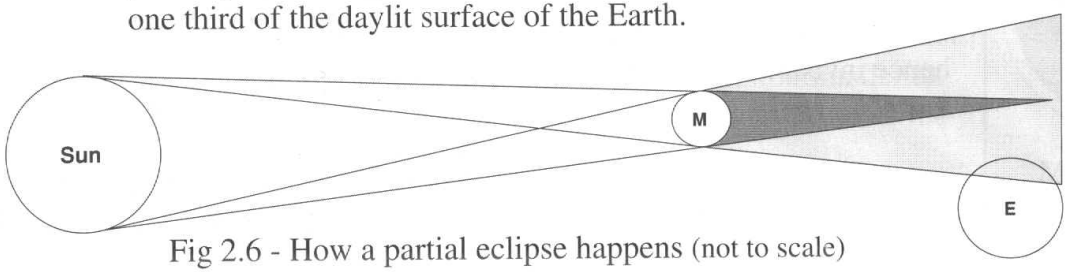
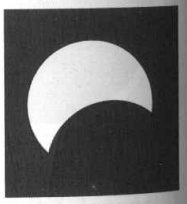


Fig 2.6 - How a partial eclipse happens (not to scale)



What you see

Types of Solar Eclipse

Annular-total eclipses

These can happen on rare occasions when the Moon's umbra is not long enough to touch the Earth's surface at the beginning **A** (and end **C**) of an eclipse, but is just long enough to strike the surface **B** in the middle of the eclipse.

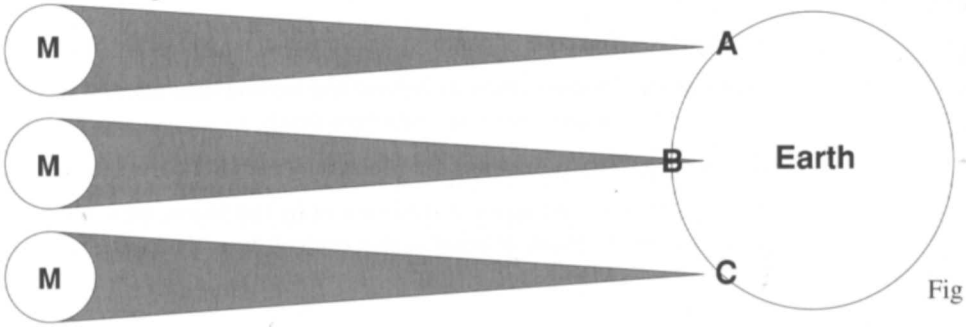
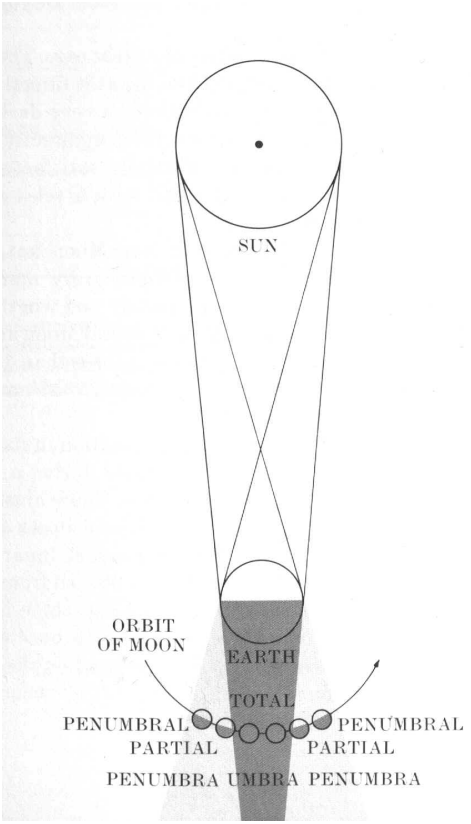


Fig 2.7

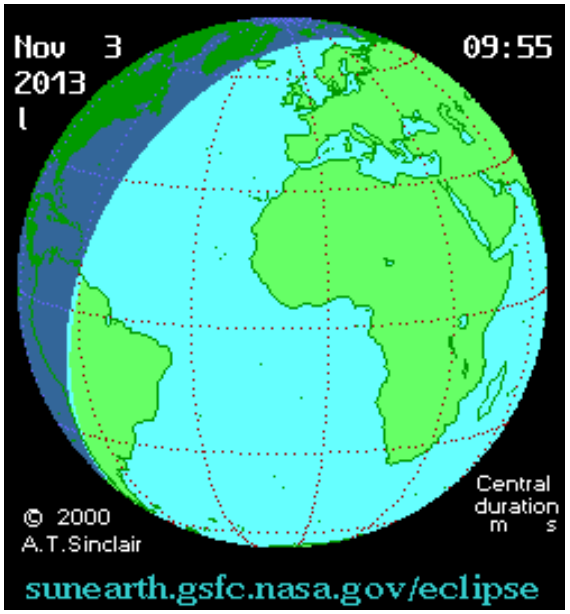
Hybrid (Annular/Total)

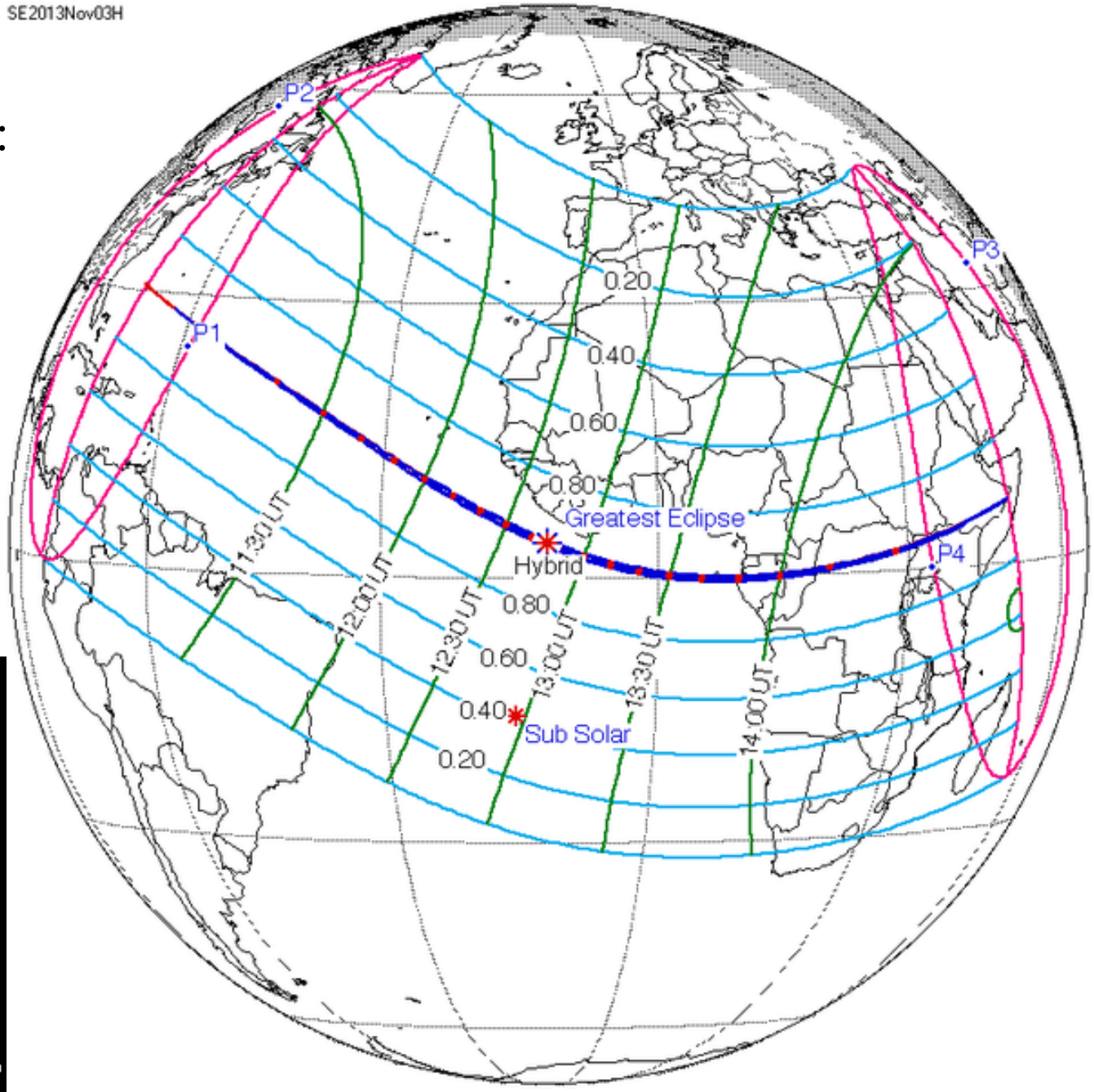
Lunar Eclipse

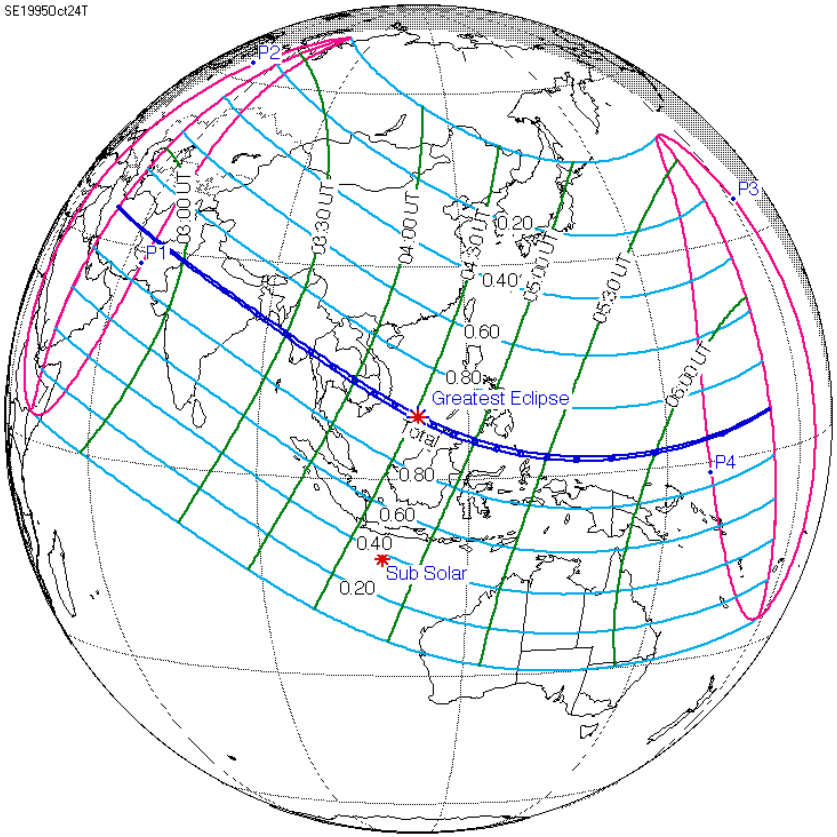


All options are either:

- Too expensive
- Too cloudy
- Too dangerous
- or Too short



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P2
P3
P4
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03:30 UT
04:00 UT
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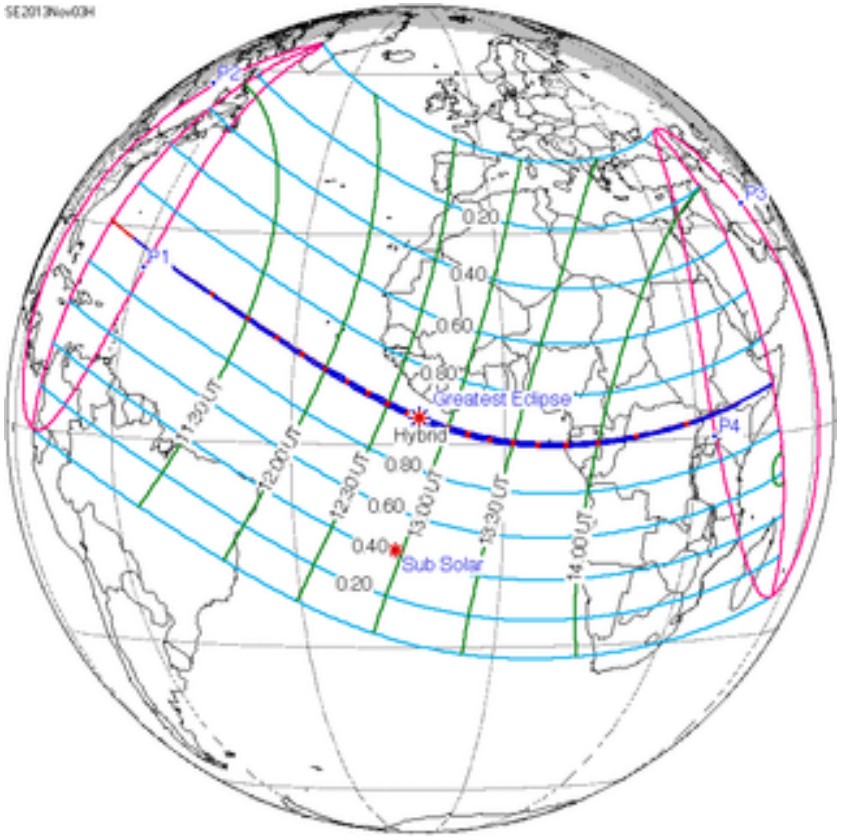
05:00 UT
05:30 UT
06:00 UT
0.20
0.40
0.60
0.80
Greatest Eclipse
Sub Solar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P4
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0.80
Greatest Eclipse
Hybrid
Sub Solar
12:00 UT
12:30 UT
13:00 UT
13:30 UT
14:00 UT

The Ancient Greeks (and possibly the Babylonians) spotted that:

18 years and 11 days after a lunar eclipse

… there was usually another lunar eclipse

The same is true (but more difficult to spot) for solar eclipses

18 years 11 days - The Saros Period

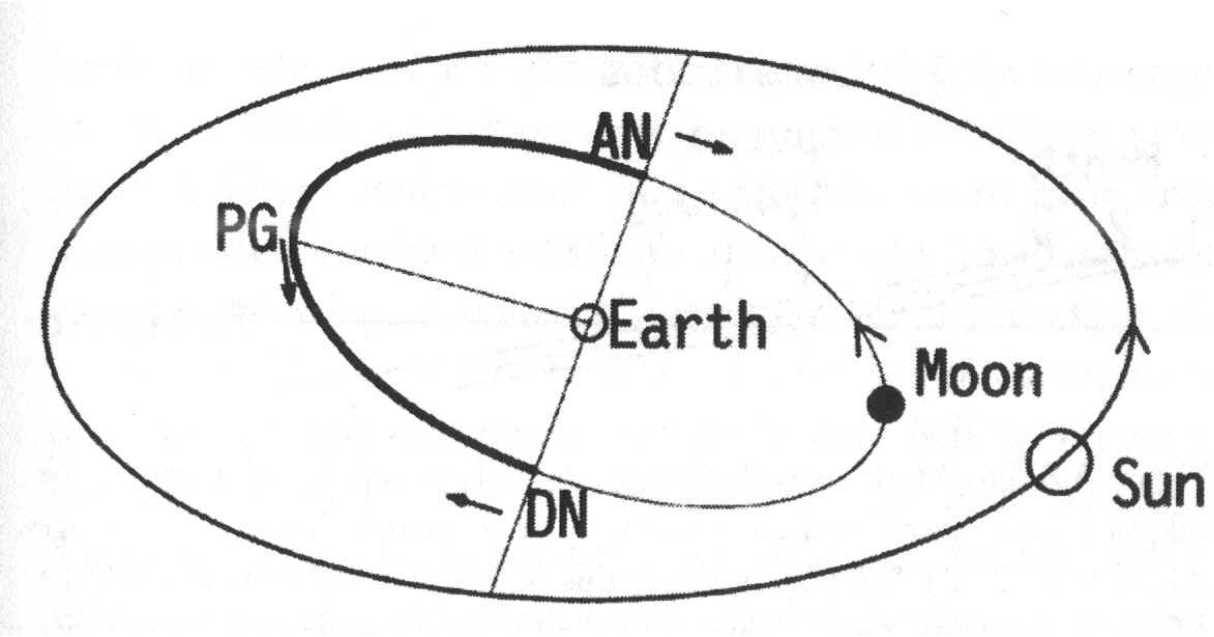
A New Moon occurs (on average) every 29.5306 days

- A SYNODIC month
- Or LUNATION
- Or LUNAR month

Solar Eclipses can only occur at New Moon

Why isn't there an eclipse every New Moon?
- because the Moon's orbit is tilted to the ecliptic

The Moon's Orbit is Tilted



An eclipse can only occur when the Moon is at a Node

Time from Ascending Node to Ascending Node = 27.2122 days

The DRACONIC month

Saros Explained

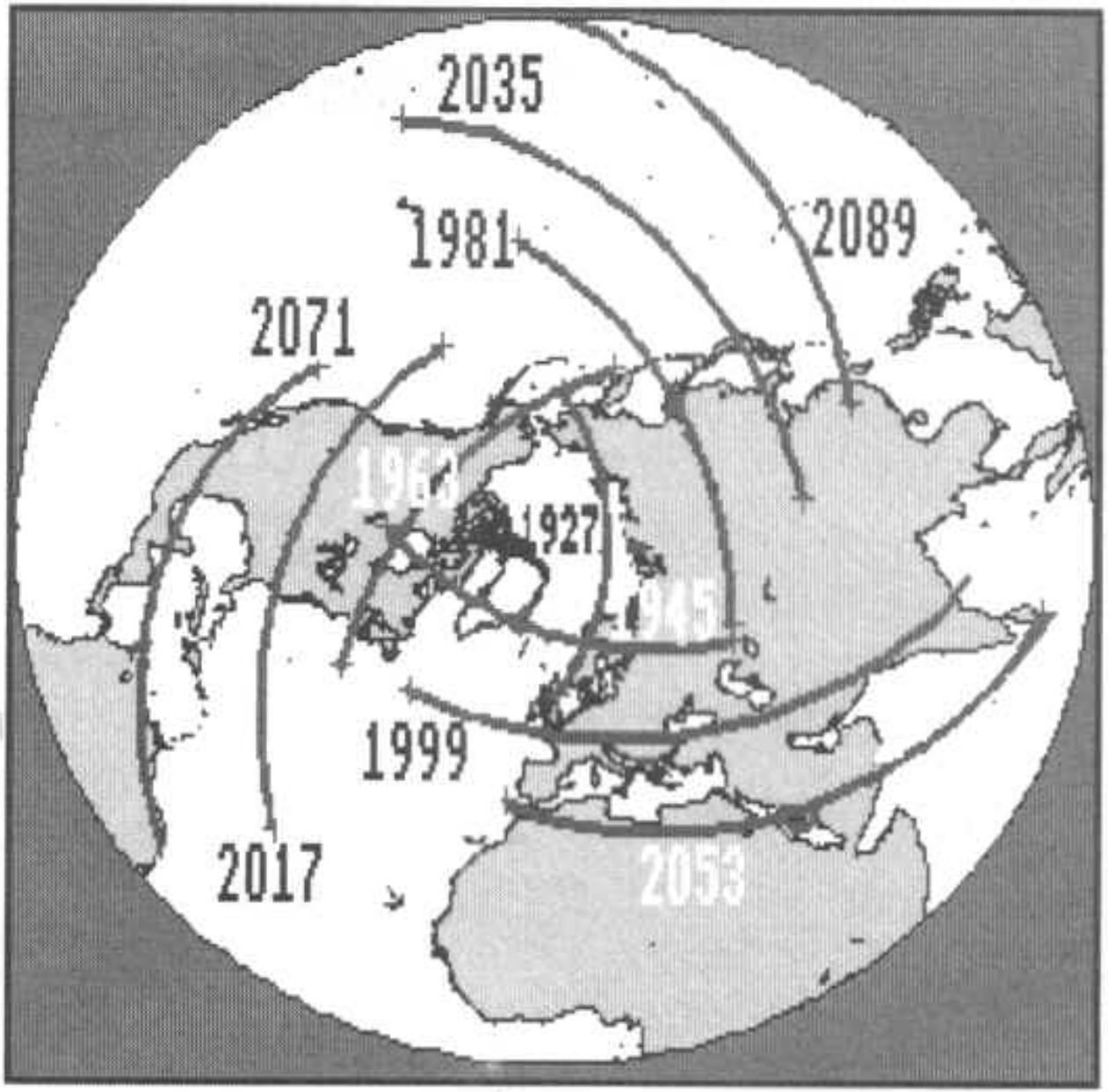
- 223 synodic months = 6585.32 days
- 242 draconic months = 6585.78 days

So, 6585.32 days after an eclipse, there's (usually) another one!

- the track is a little further north or south

6585.32 days is 18 years 11.32 days (or 10.3/12.3)

0.32 days means the Earth has spun through 120 degrees



Saros 145

Saros 136

- First eclipse, June 22nd 1360, partial at the South Pole
- Last eclipse, July 30th 2622, partial at the North Pole
- Longest eclipse, June 20th 1955, 7 mins 9 secs totality
- Recently, July 11th 1991, Hawaii & Baja California
- And July 22nd 2009, India, China & South China Sea

Saros 136 contains 71 eclipses:

- 45 total eclipses
- 7 annular eclipses
- 5 annular-total eclipses
- 14 partial eclipses

The Inex Series

Described by Professor G van der Bergh (1955)

358 Synodic Months = 388.5011 Draconic Months

28 years 345 days after an eclipse, you get another one,
at almost the same longitude, and the opposite latitude

At present, an Inex series consists of

- 140 partial eclipses, starting at the poles, followed by
- 250 total eclipses, moving away from the equator, finishing with
- 250 total eclipses, moving closer to the equator, then
- 140 partial eclipses, finishing at the poles

23 000 years in duration!!

Saros and Inex Connections

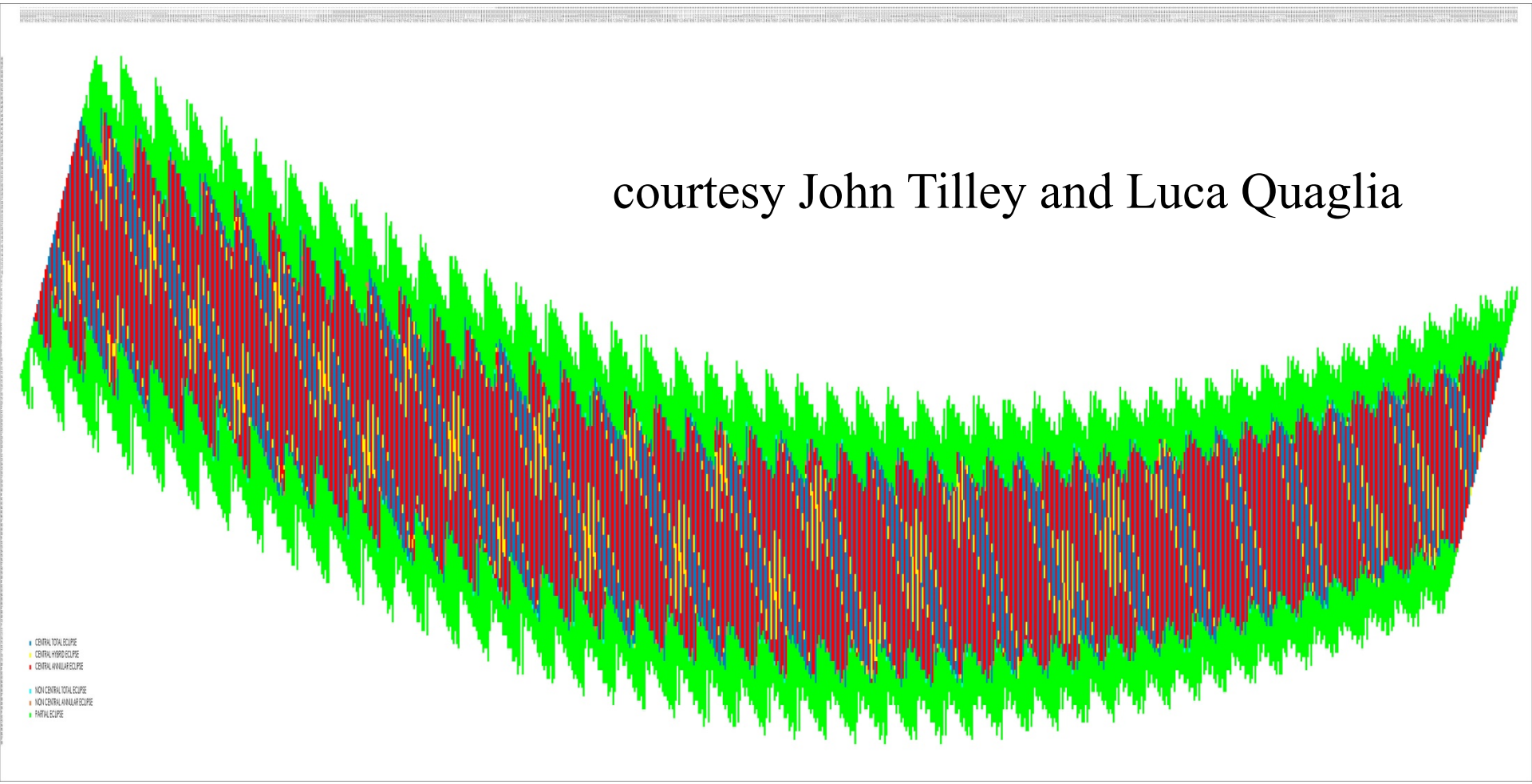
80+ Saros series in progress at any time

A new Saros is born every Inex (every 29 years)

Every solar eclipse is in a unique Inex and Saros pair

"*Professor van der Bergh constructed a beautiful 'panorama of eclipses', in which all eclipses from 1207 BC to 2061 AD appeared. Each column is a Saros series, each row an Inex series*"

A Chart of Saros and Inex Pairs



Blue – Total, Red – Annular, Yellow – Annular/Total, Green-Partial

Sources & Acknowledgements

- “Eclipse”, Duncan Steel
- “UK Eclipses from Year 1”, Sheridan Williams
- “Total Eclipses of the Sun”, J.B.Zirker
- “Mathematical Astronomical Morsels”, Jean Meeus
- Saros / Inex Chart by John Tilley & Luca Quaglia

Forthcoming Eclipses

- April 29th 2014 – ANNULAR (Interior Antarctica)
- March 20th 2015 – TOTAL (North Atlantic, Faroe Islands, Svalbard)
- March 9th 2016 – TOTAL (Indonesia, Central Pacific)
- September 1st 2016 – ANNULAR (Central Africa)
- February 26th 2017 – ANNULAR (South America, Southern Africa)
- August 21st 2017 – TOTAL (Continental USA)