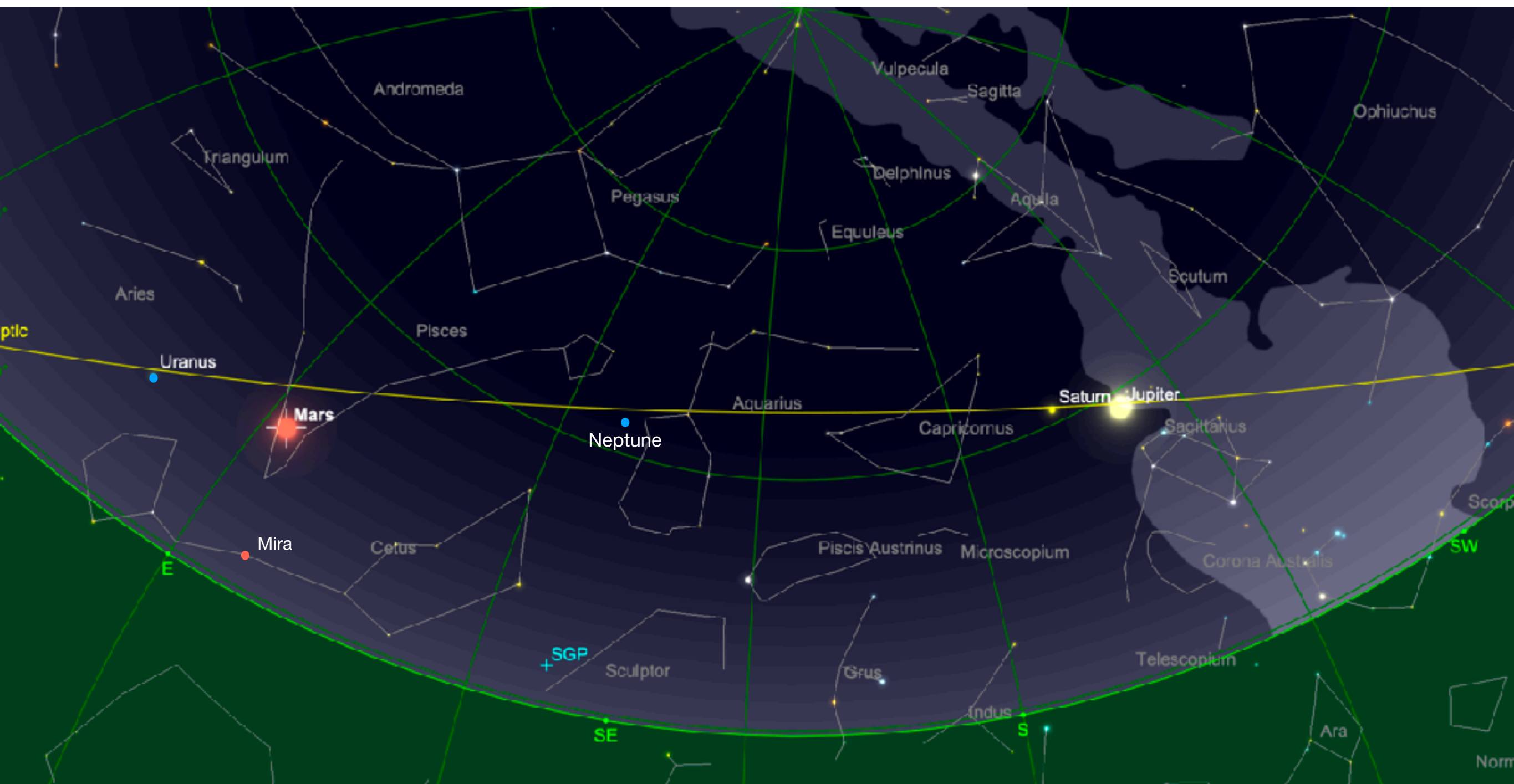


# Mars and Mira

Santa Fe Star Gazers  
16 September 2020



**Looking SE at 10 pm, 16 Sept. 2020 from Santa Fe**

# Syzygy ('siz-i-jē)

- Definition: A roughly straight-line configuration of three or more celestial bodies in a gravitational system.
- Origin: From the Greek meaning “yoked together”
- Examples: Oppositions, conjunctions, transits, eclipses, full and new moons.

# **Mars in an Opposition Syzygy**

**13 Oct 2020**

# Apparent Size of Mars During this Apparition

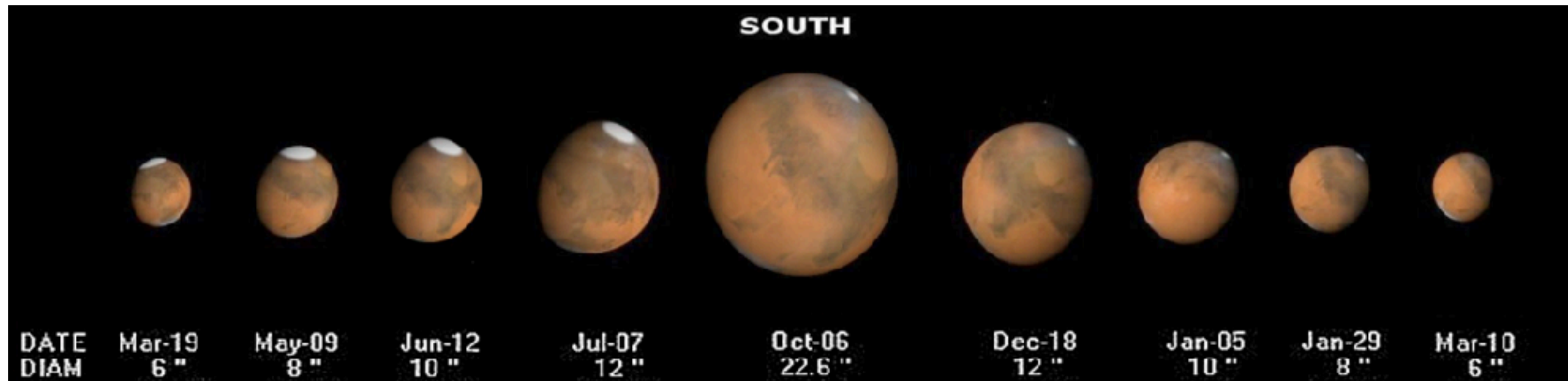


Photo credits:

Association of Lunar and Planetary Observers (ALPO) Mars Section

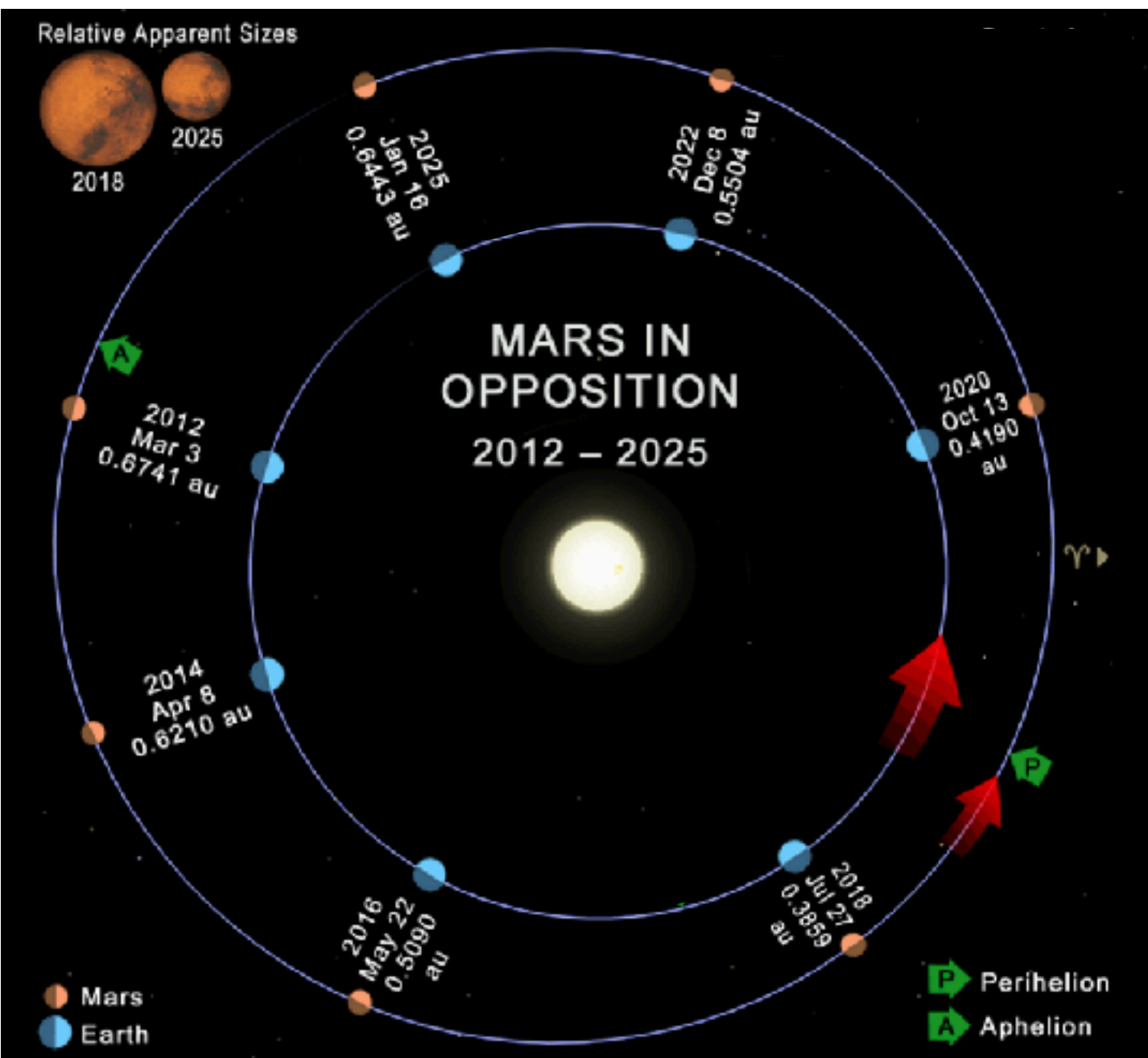
- Don't miss this one, because the next, closer opposition is 2035.
- Apparent diameter at closest point of approach: 22.6"
- That's 1.7" smaller than in 2018. But ... since Mars is in Pisces now ( $\sim 7^\circ$  above the celestial equator) and was in Capricornus for the last opposition ( $\sim 25^\circ$  below the equator), Mars transits now some  $32^\circ$  higher in the sky. So this is a very good Northern Hemisphere opposition.
- At opposition, Mars (mag. -2.6) will be brighter than Jupiter (mag -2.3).
- Mars Perihelion      3 Aug 2020      Earth-Mars Distance: .6255 AU  
 Closest Approach   6 Oct 2020      Earth-Mars Distance: .4149 AU  
 Opposition            13 Oct 2020      Earth-Mars Distance: .4194 AU

Ques: Why does closest approach happen before opposition?

Ans: Because Mars' orbit is distinctly elliptical, not circular. And this year, Mars perihelion occurred well before opposition, which caused closest approach to also be before opposition.

- The close Mars oppositions occur when Mars is near perihelion, and are called "perihelic oppositions". The Mars Section of the Association of Lunar & Planetary Observers (ALPO) specifies which oppositions are perihelic.

# Time Between Oppositions, the Synodic Period



$\alpha_E$  = Earth orbits per year = 1

$\alpha_M$  = Mars orbits per Earth year = .53166

Solve for the synodic period  $t_S$ , where

$$t_S \alpha_E = t_S \alpha_M + 1$$

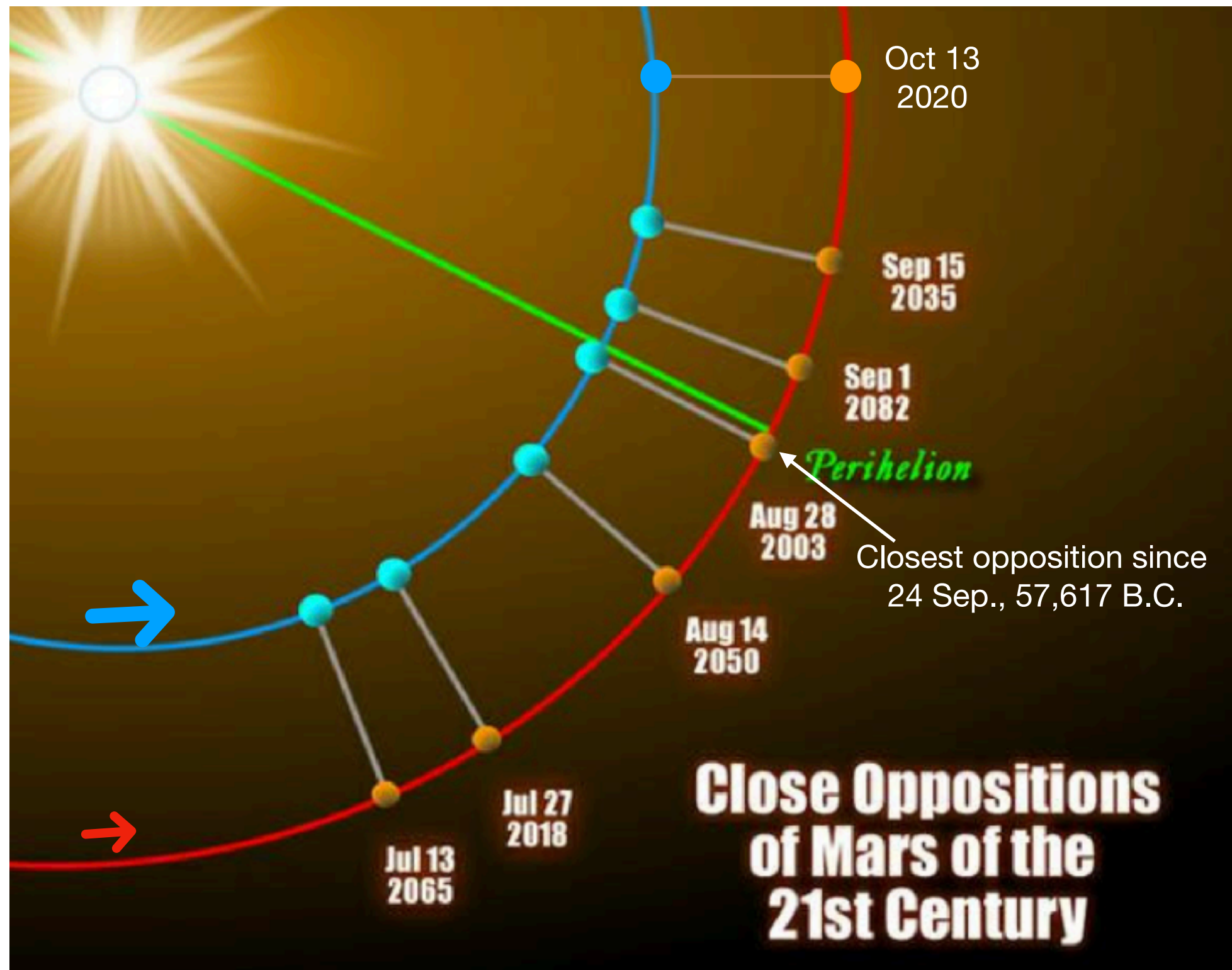
So,

$$t_S = \frac{1}{\alpha_E - \alpha_M} = 2.1352 \text{ years}$$

- ★ Assumes constant speed, circular orbits. So this simple formula is only approximate.
- ★ For example, the time between the last opposition and the current one has been about 2yr, 2.5 months = 2.21 yr.



# Close Mars Oppositions Occur Near Mars Perihelions





# OPPOSITIONS OF MARS, 2010–2022

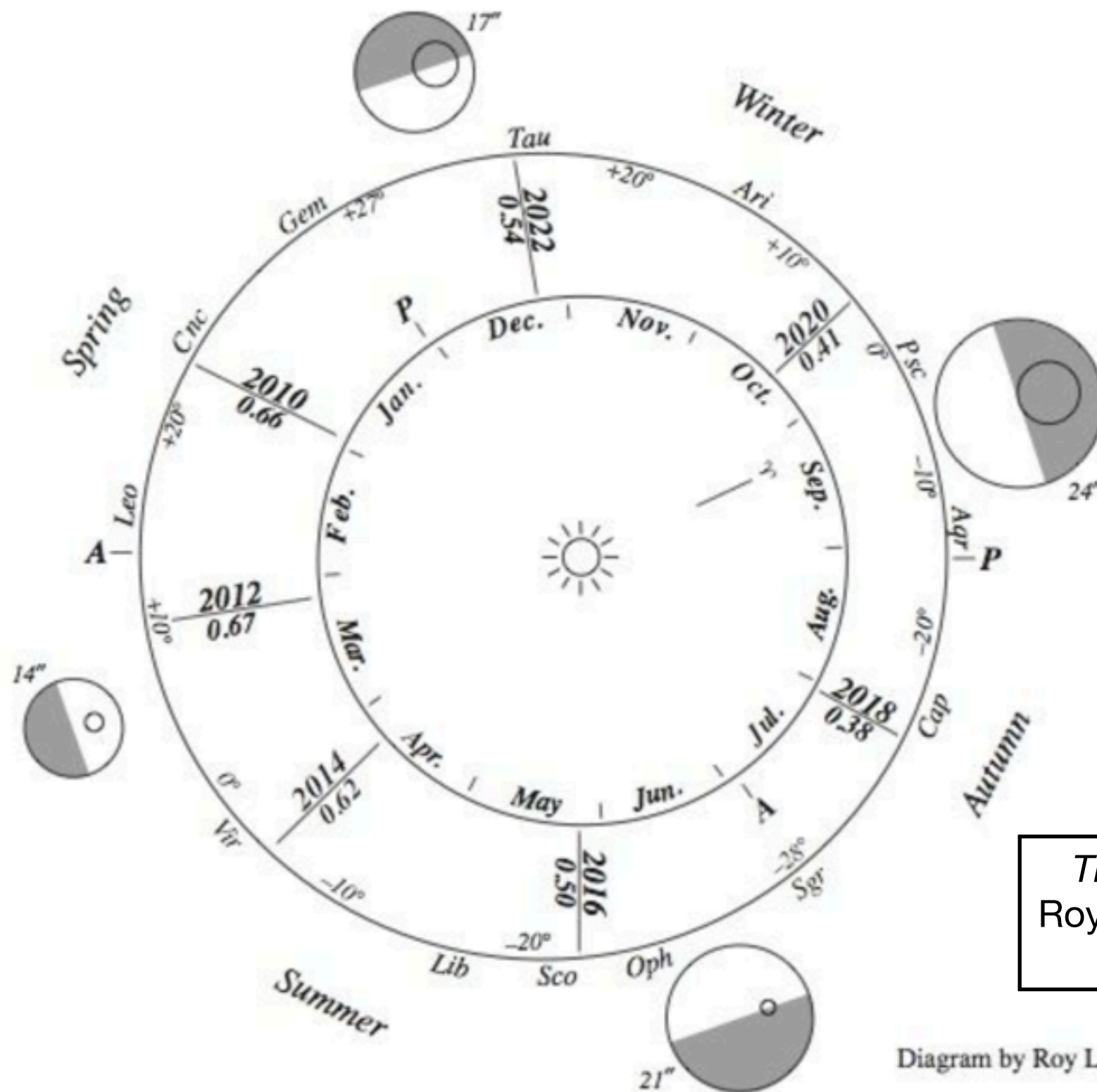
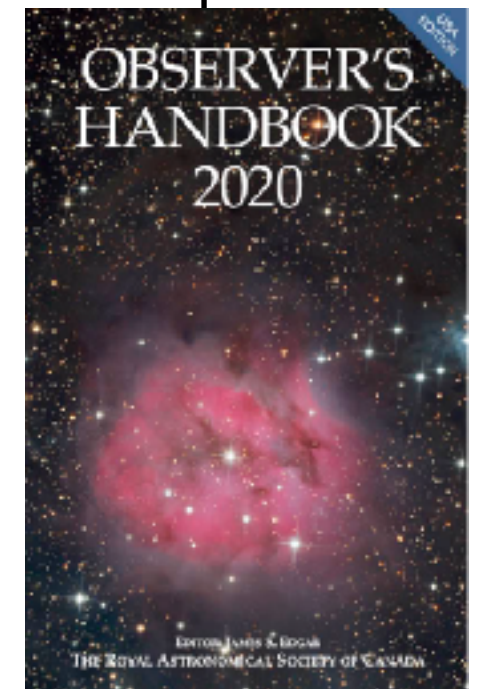
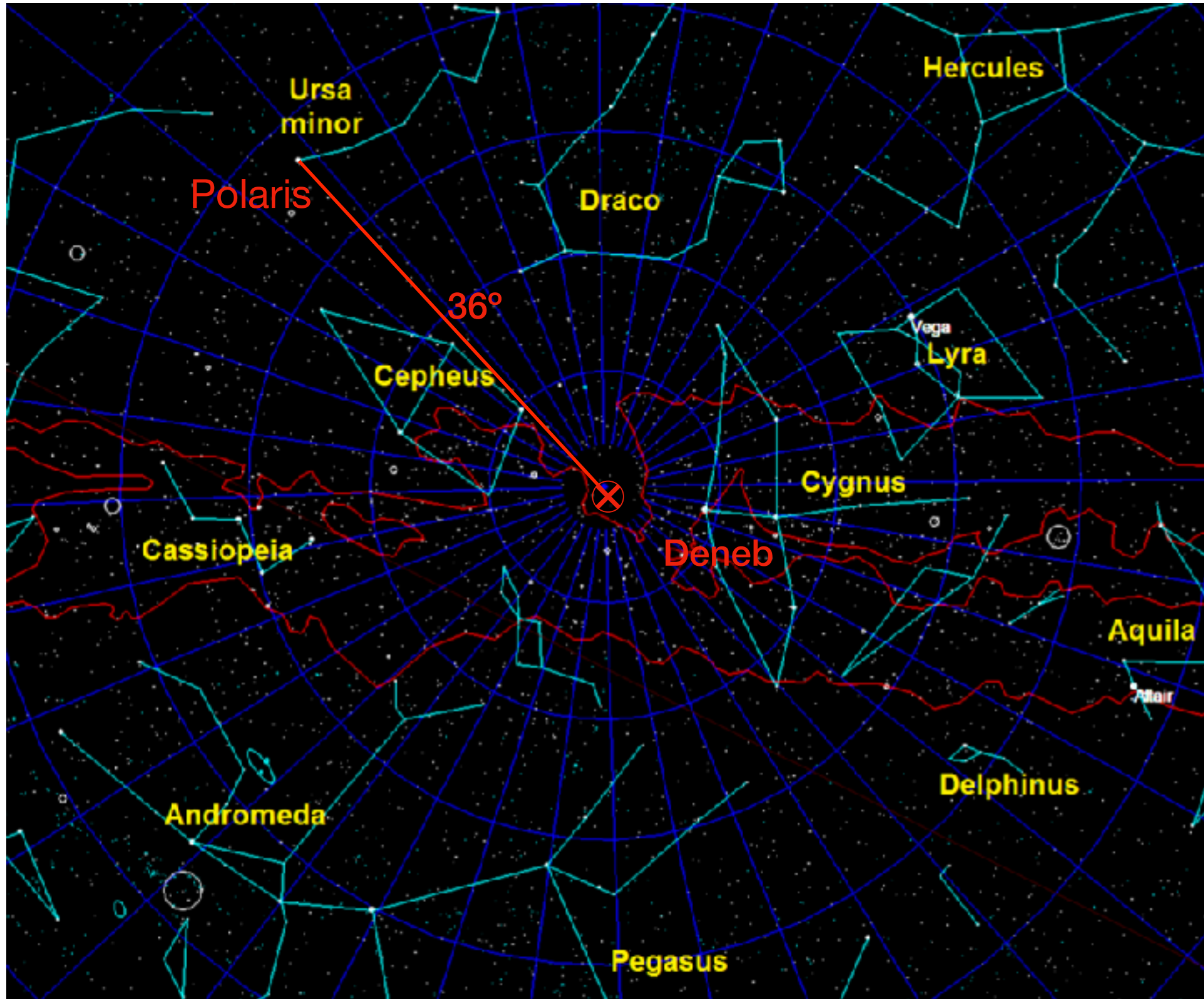


Diagram by Roy L. Bishop

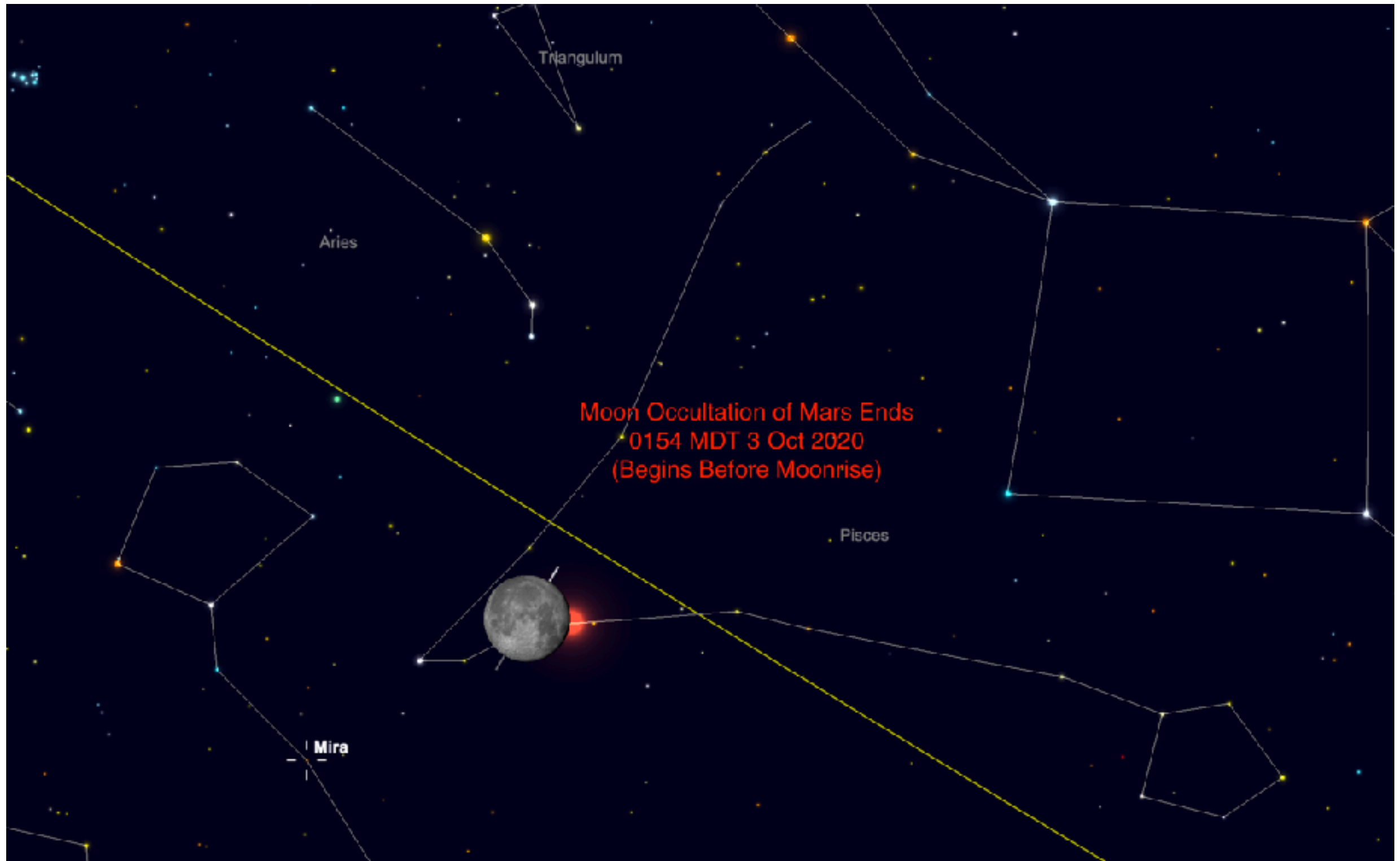


*The Observer's Handbook*  
Royal Astronomical Society of  
Canada

# Celestial North Pole on Mars



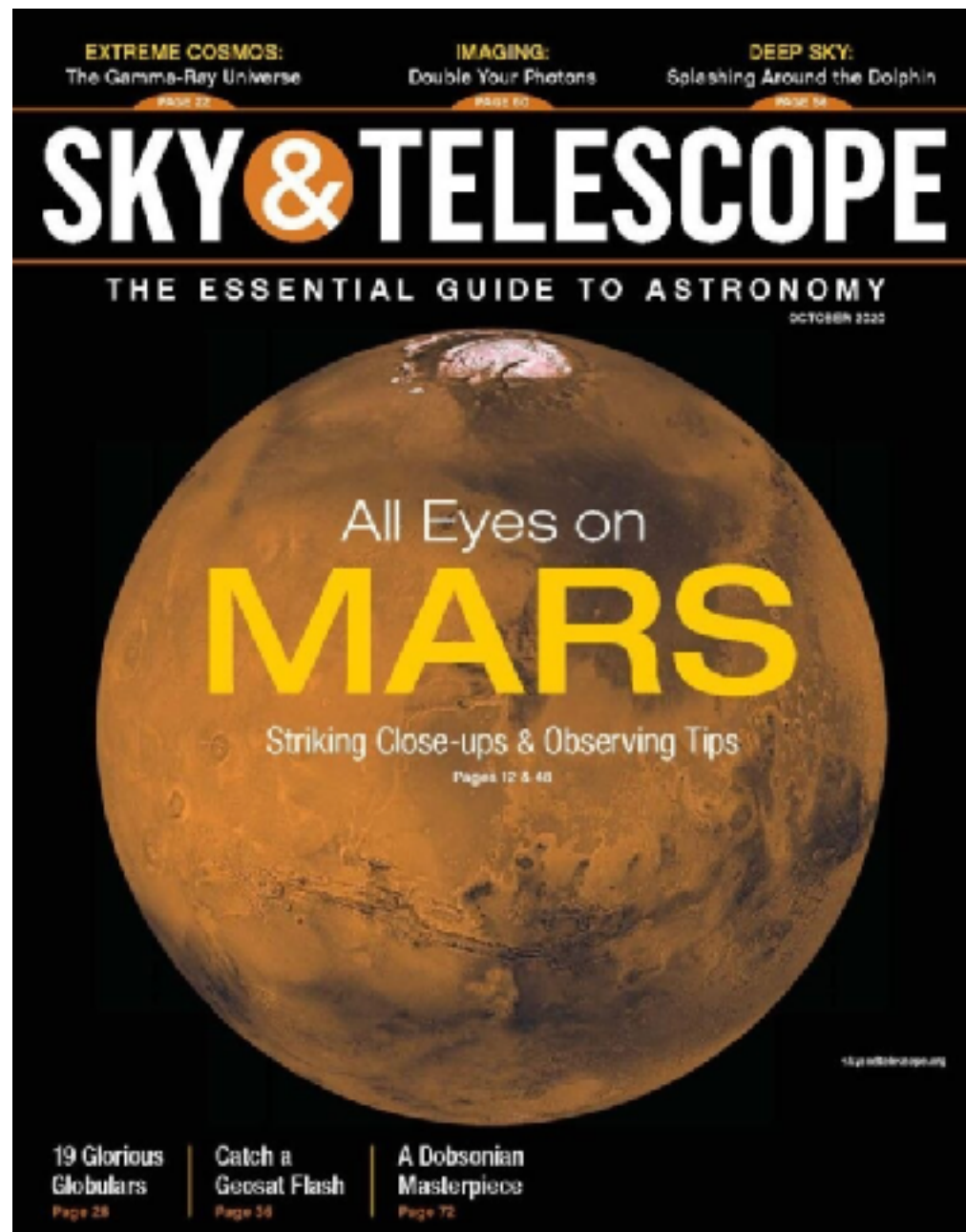
# Occultation of Mars






# Observing Mars

## What to Look For



*The Strolling Astronomer*



### Feature Story

## A Preview of the 2019 – 2021 Perihelic Apparition of Mars

By Roger Venable,  
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and Jeff Beish  
[ajb\\_jen139@comcast.net](mailto:ajb_jen139@comcast.net)

### Introduction

The most colorful of planets has begun a perihelic apparition that will be the second best apparition since 2003. Observers all over the world will have good views. You will want to make Mars a priority in your 2020 observing plans.

### The Apparition

Salient dates of the apparition, together with magnitude and apparent diameter on those dates, are listed in Table 1. Traditionally, the observing season has been considered to start when the apparent diameter of Mars reaches 6 arc seconds and to end when it declines to that size. The beginning and end of the observing season given in Table 1 reflect that tradition. For many visual observers, 6 arc seconds remains a reasonable limit,

but some images have been making useful observations of dust storms, clouds, and polar cap changes when Mars is as small as 4 arc seconds in diameter. Furthermore, many modern amateurs use instruments larger than those available to previous generations, so that the 6 arc second limit may seem obsolete.

This is a perihelic apparition, so that Mars will appear bright in the naked eye and large in the eyepiece. The only opposition since 2003 in which Mars appeared this large and bright was the 2018 apparition. As Table 1 indicates, the brightness at opposition will be -2.62 magnitude, while at closest approach to Earth it will be slightly less bright at magnitude -2.57 magnitude. This is slightly less brilliant (0.16 magnitudes fainter) than Mars was when at its brightest during the 2018 apparition. Note that when Jupiter is at opposition on July 14, 2020, the gas giant will be of magnitude -2.8, so Mars will not outshine it in 2020.

**Table 1. Important Dates of the 2019 – 2021 Apparition**

yyyy-mm-dd*	Event	Mag	Diam**
2019-09-02	Opening conjunction	1.73	3.50
2020-03-19	Observing season begins	0.82	6.00
2020-05-21	Western quadrature***	-0.34	10.72
2020-06-09	Retraining station begins	-2.07	20.20
2020-10-08	Closest approach	-2.57	22.57
2020-10-14	Opposition	-2.62	22.33
2020-11-15	Retraining station ends	-1.64	17.57
2021-01-22	Eastern quadrature***	0.29	8.50
2021-03-10	Observing season ends	1.05	6.00
2021-10-08	Ending conjunction	1.64	3.55

\* Dates are in universal time.  
\*\* "Diam" is the apparent subtended diameter in arc seconds.  
\*\*\* Quadratures are determined as the dates when the actual separation in the sky is 90 degrees, rather than the separation as measured with reference to the celestial equator.

### Online Features

Left-click your mouse on:

- The authors' e-mail addresses in [blue text](mailto:rjvmd@hughes.net) to contact them.
- The hyperlinks and source material references in [blue text](#) to jump to source material or information about that source material (Internet connection must be ON).

Table 1 indicates that the closest approach to Earth will occur eight days before opposition. This is due to the opposition's occurrence somewhat after Mars's perihelion. For the same reason, Mars will appear larger and brighter at western quadrature than it will at eastern quadrature.

Figure 1 graphs the Martian apparent diameter and magnitude as they change with the progression of this apparition. At close approaches such as this one, the observing season is longer than it is at aphelic oppositions — 357 days in 2020 (about as long as the 353 days in 2018), and better than the 341 days in 2016.

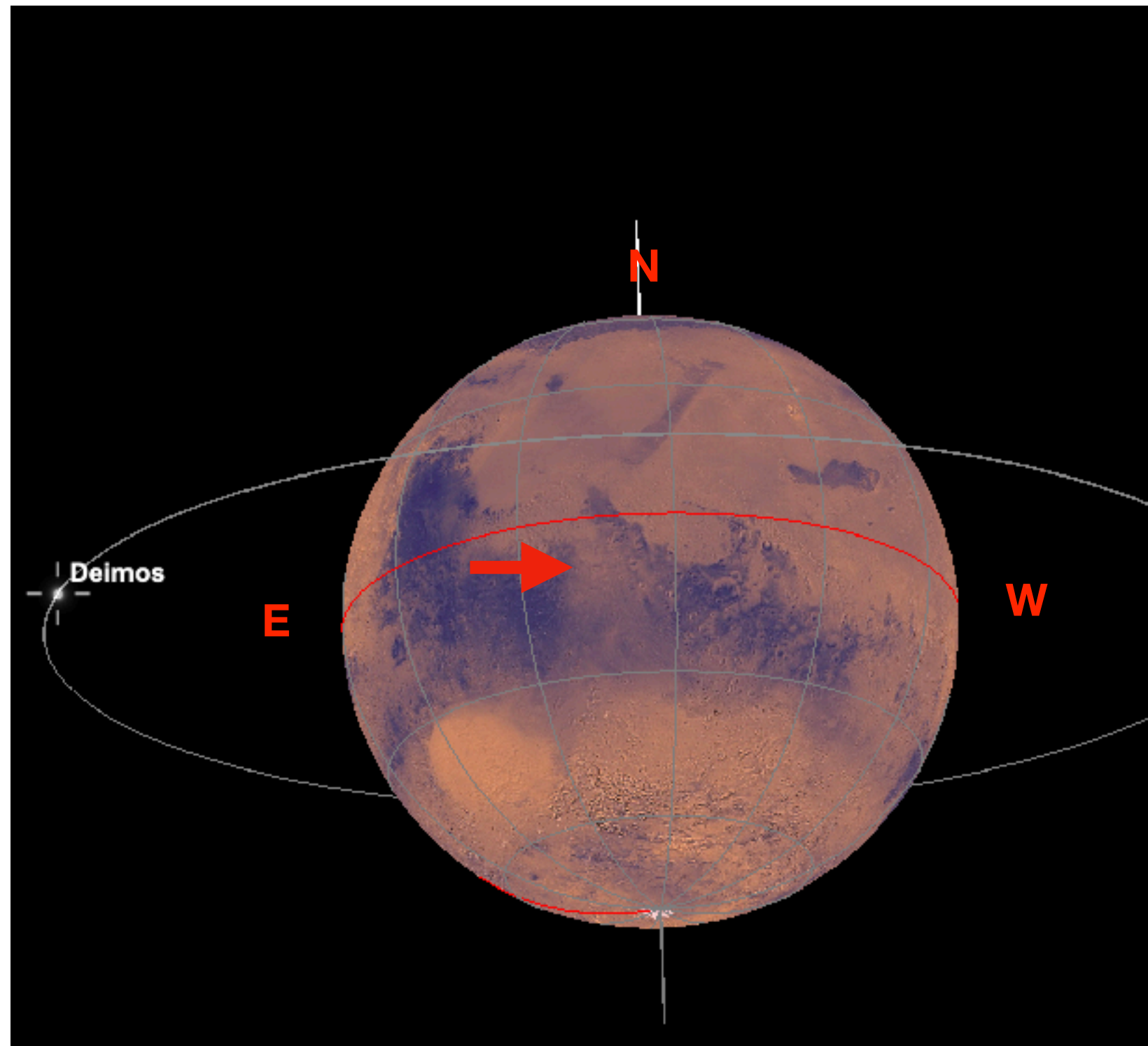
### Mars in the Sky

During apparitions that have the closest oppositions, such as the 2018 apparition, the planet Mars usually has a southerly declination in Earth's sky for most of the observing season. In contrast, during this apparition Mars will be south of the Celestial Equator until July 12, 2020, when it enters the northern sky, where it will stay throughout the rest of the apparition. Its declination will be +5.3 degrees at its opposition on July 27, 2020, but the most northerly declination of +24.9 degrees will not occur until April 24, 2021. The changes in declination as the

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# What to Look For with a Small Telescope

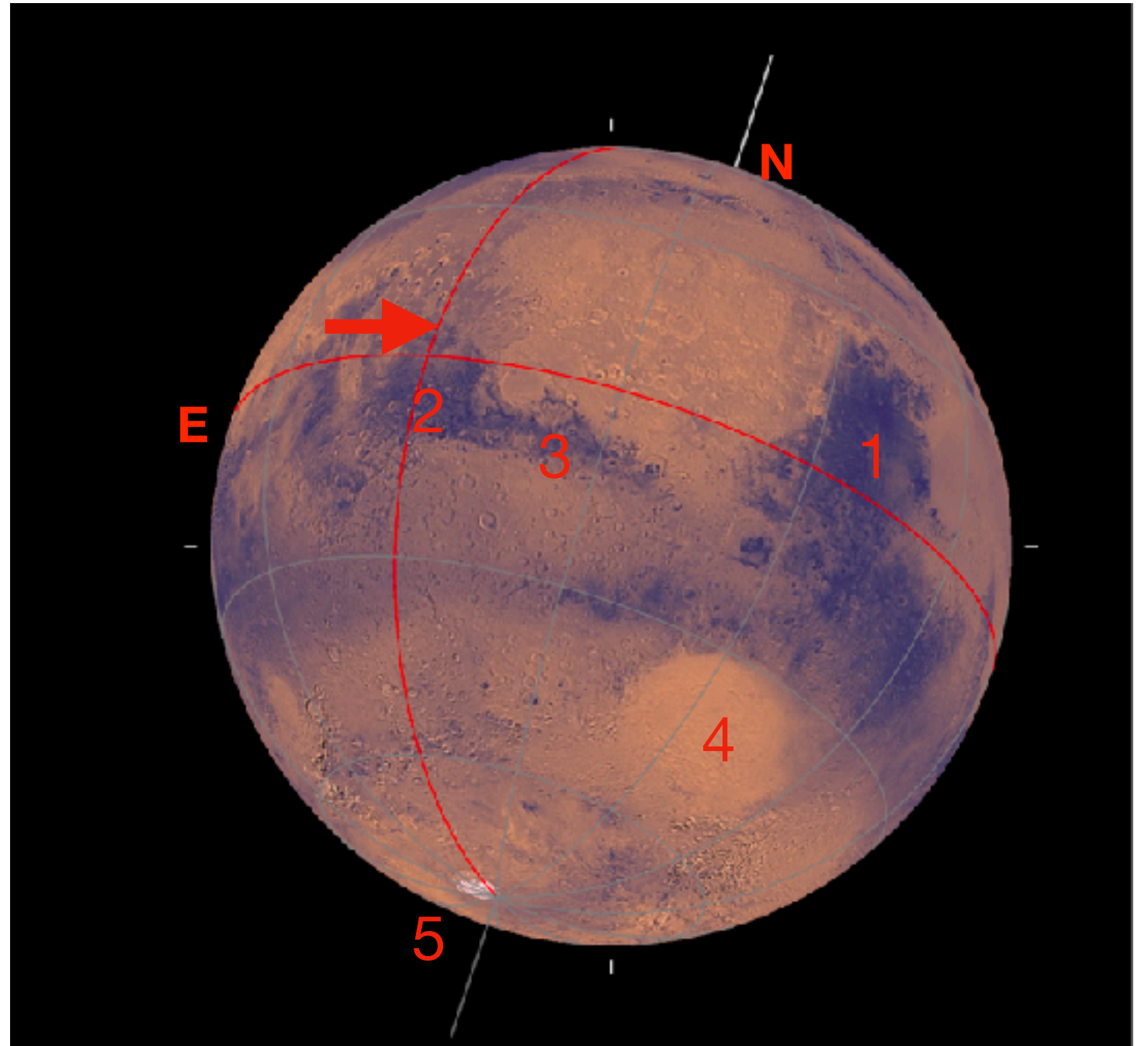
- Mars Northern Polar Cap (NPC) tilted away from Earth  $20^\circ$ . Southern Hemisphere summer. A remnant of  $\text{CO}_2$  ice might remain.
- Northern Polar Cap (NPC) not visible, but Northern Polar Hood (NPH) cloud might be visible.
- Features rotate from celestial east to west. Mars' day is 37m 23s longer than Earth's.
- Observed at same time each night, features move east about  $10^\circ/\text{day}$  because of Mars' slower rotation.





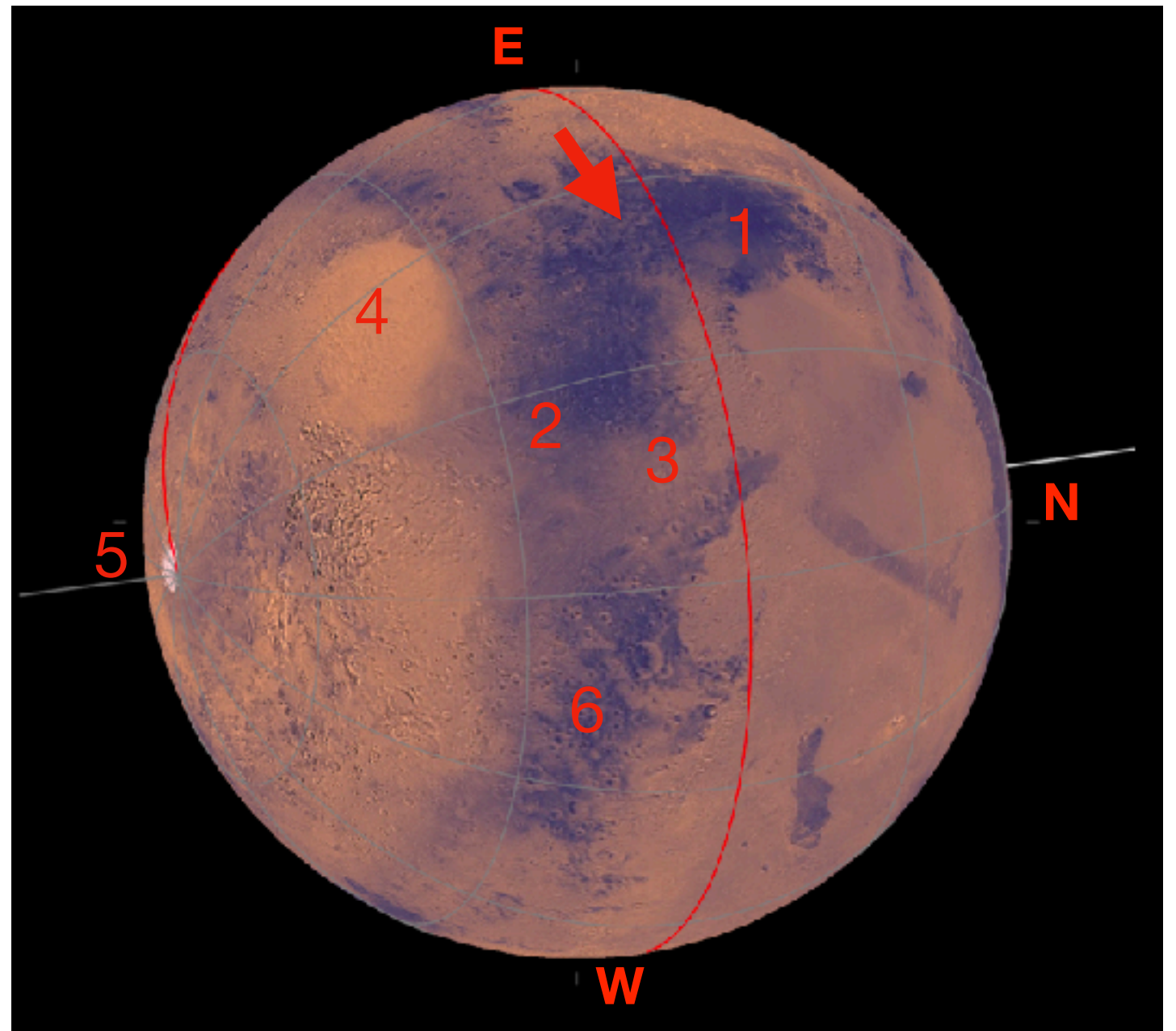
# Syrtis Major East Face

1. Syrtis Major
2. Sinus Meridiani
3. Sinus Sabaeus
4. Hellas Basin
5. Southern Polar Cap



# Syrtis Major West Face

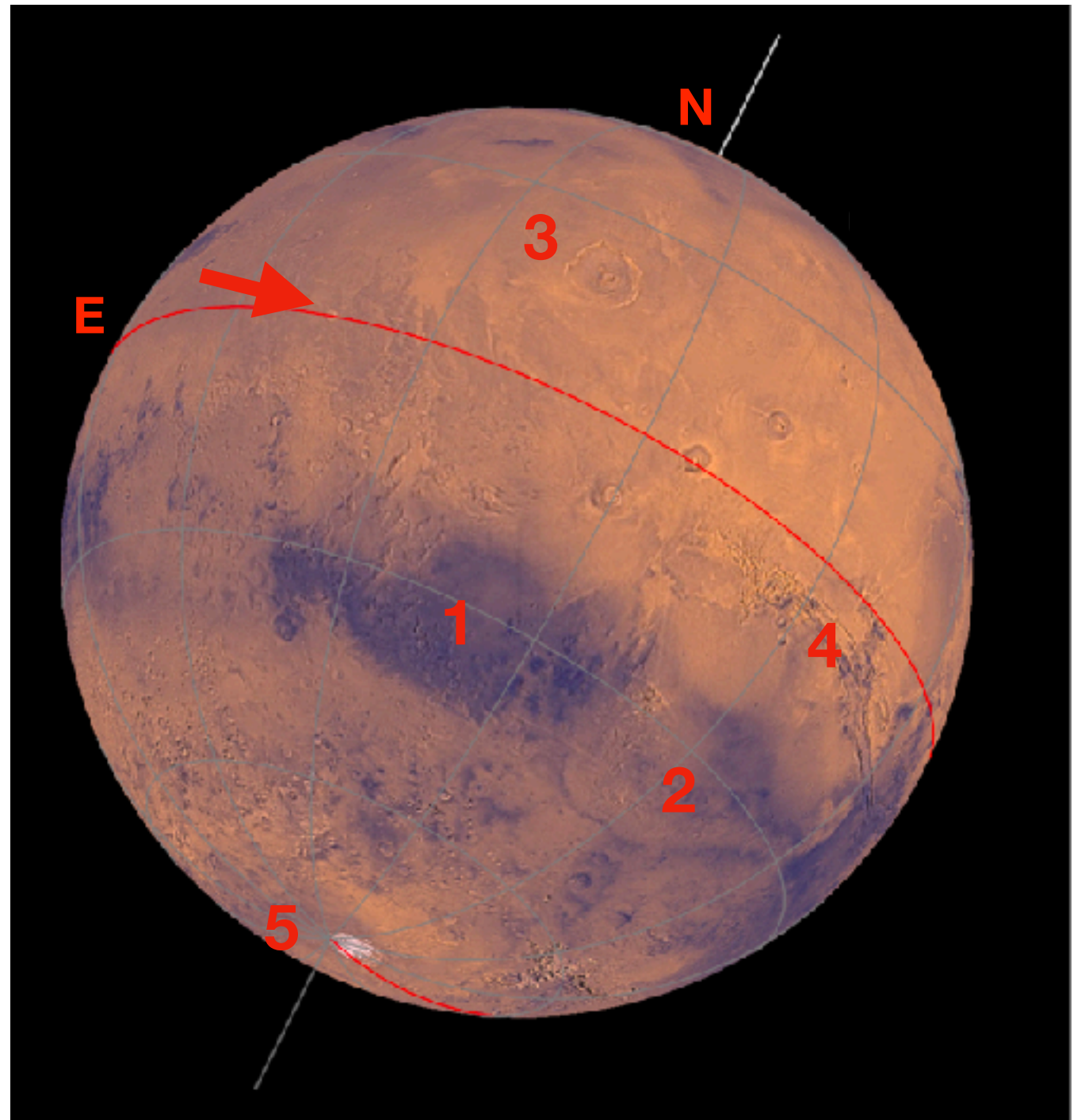
1. Syrtis Major
2. Mare Tyrrhenum
3. Hesperia
4. Hellas Basin
5. Southern Polar Cap
6. Mare Cimmerium





# Mare Sirenum Face

1. Mare Sirenum
2. Solis Lacus
3. Olympus Mons
4. Valles Marineris
5. Southern Polar Cap



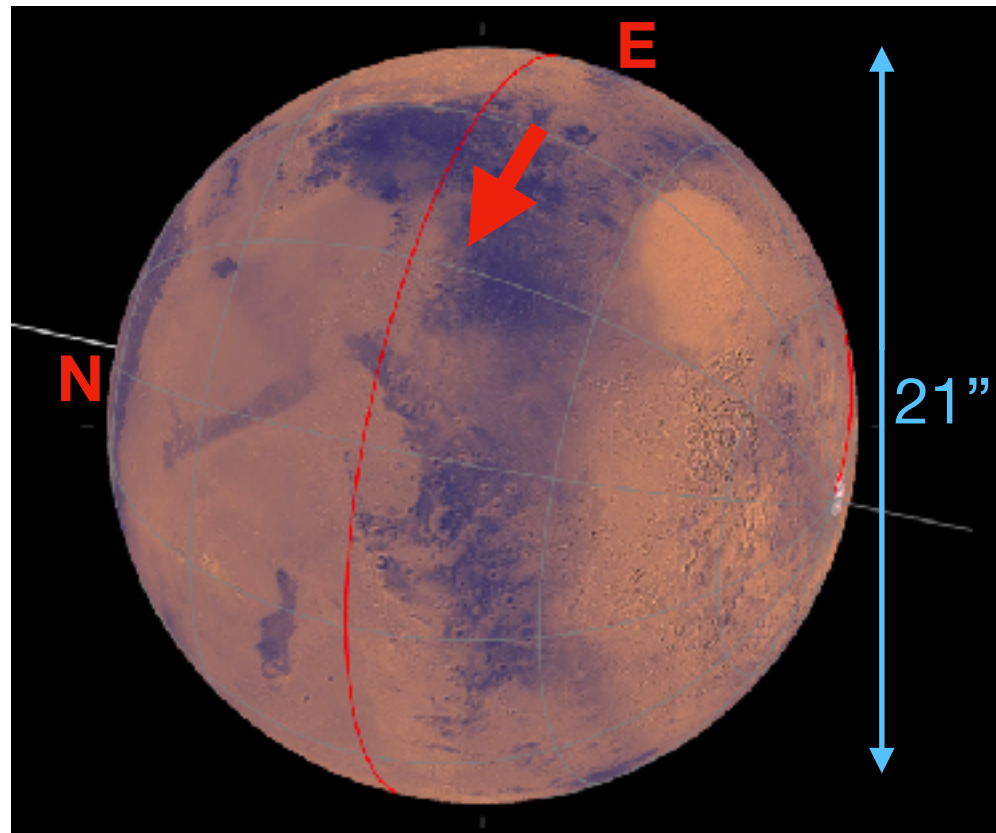
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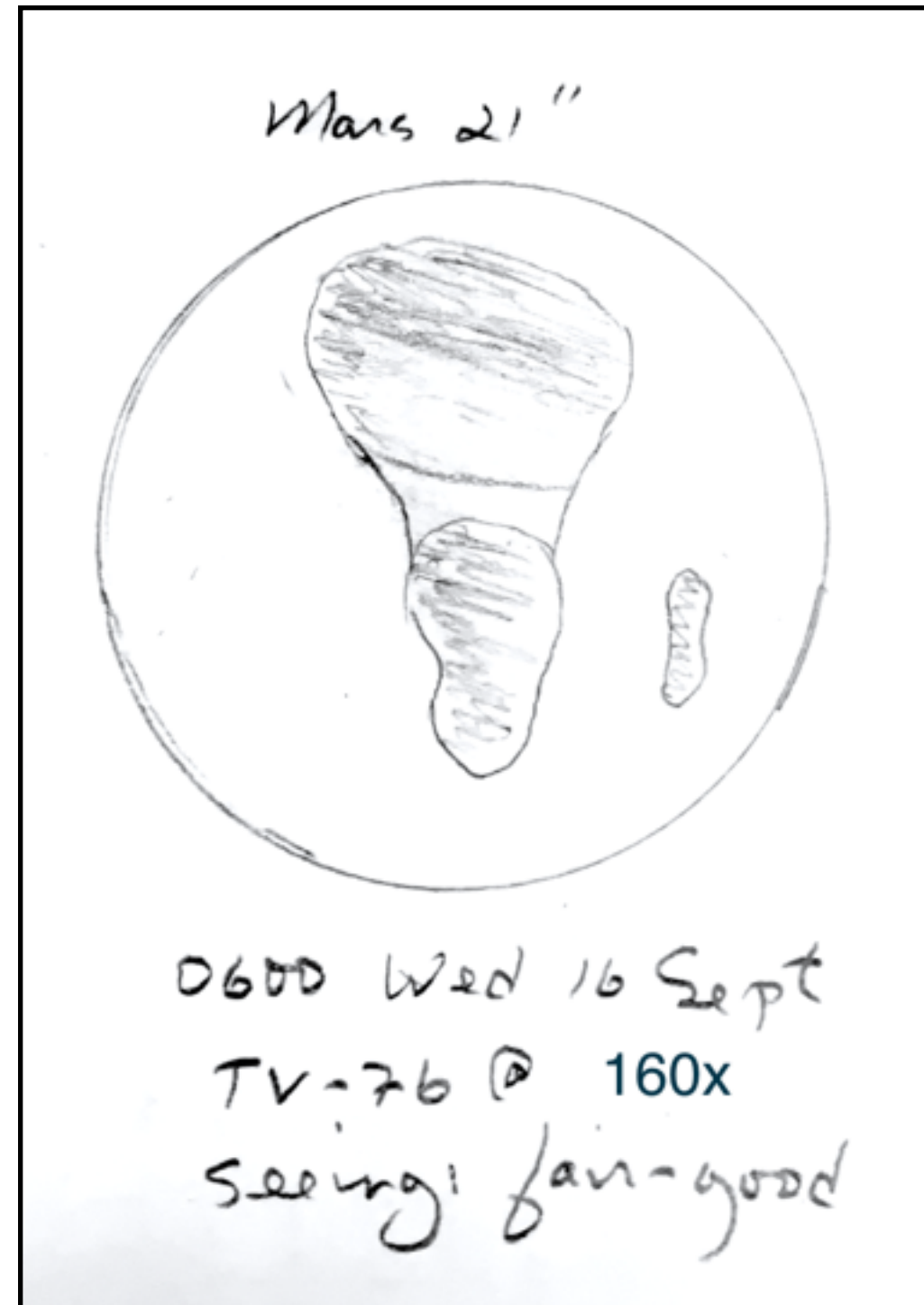


# Rough Sketch this Morning



Sky Safari simulation  
(Image flipped horizontally)

- Astronomic dawn at 0521, but image was reasonably good until at least 0600, when only 1st and 2nd mag. stars were visible.
- Also transparency was not good (high smoke, probably).

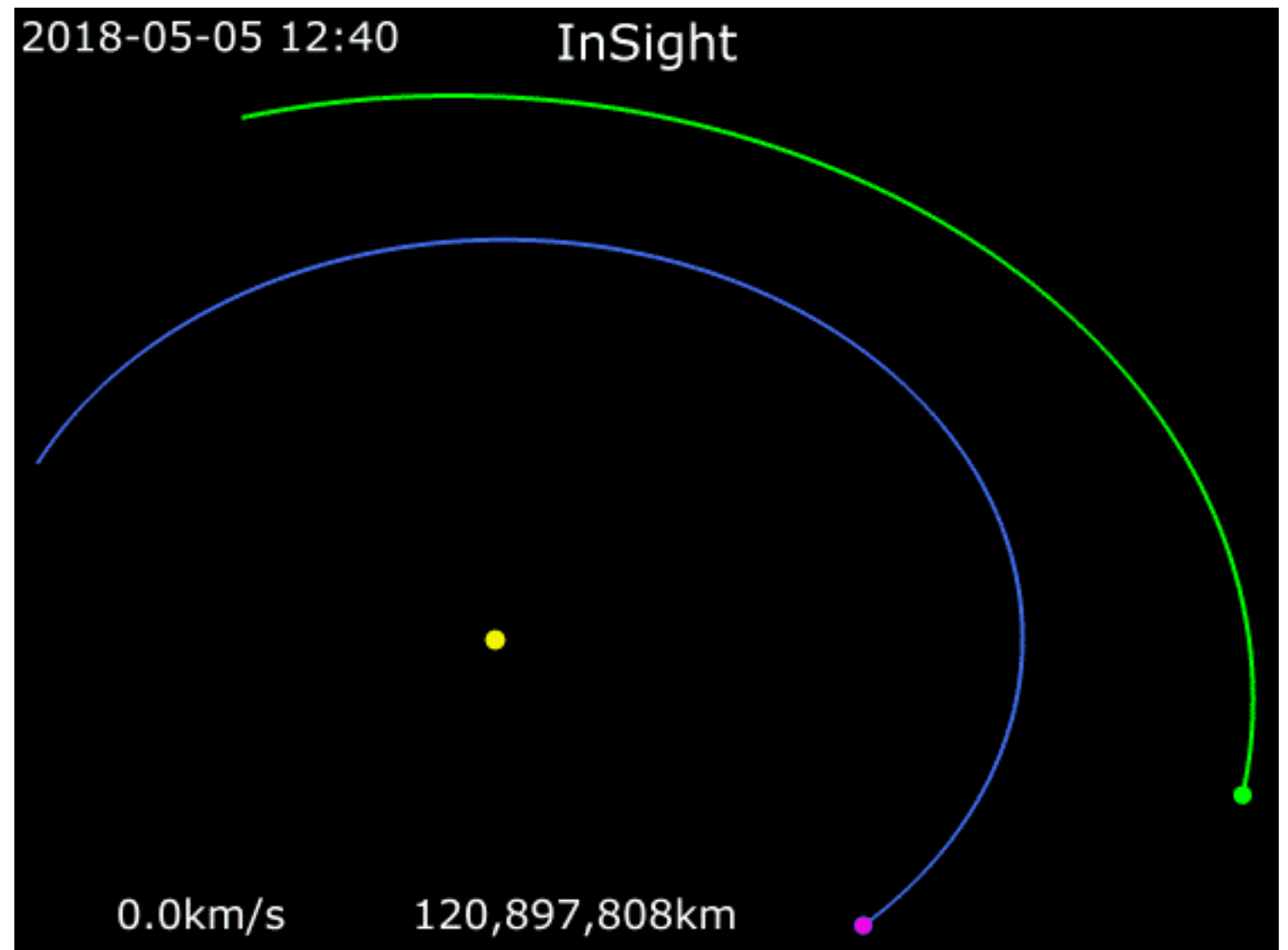


# Why Were 3 Mars Missions Launched Approx. 2 Months before Opposition?

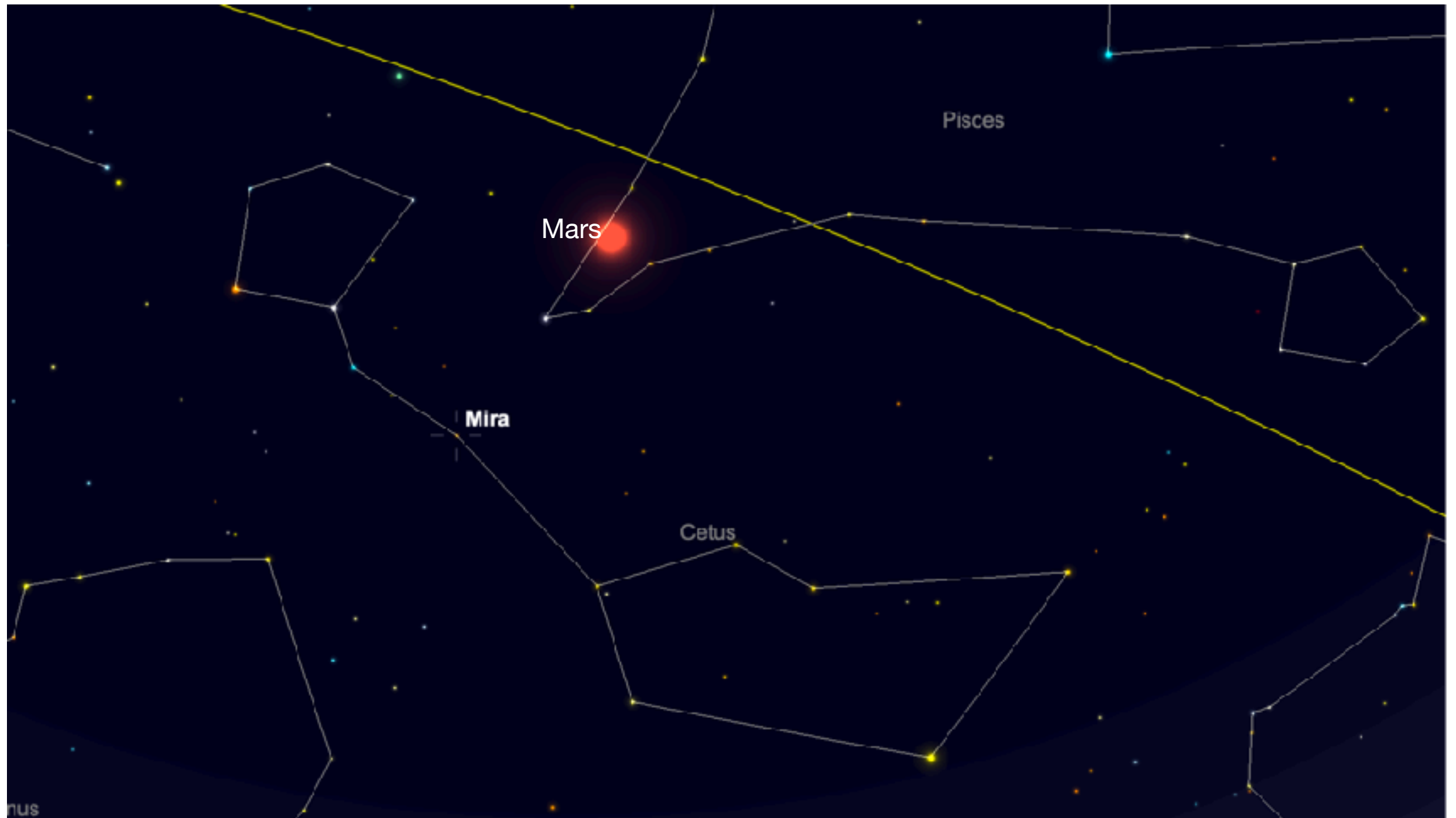
- NASA Perseverance
  - 30 July 2020 -18 Feb 2021
- UAE Hope Mars Mission
  - 19 July 2020 - Feb 2021
- China's Tianwen 1
  - 23 July 2020 - Feb 2021

Hohmann Transfer Orbit (HTO) is a low-energy elliptical orbit which can move a spacecraft from one circular orbit to another with low energy expenditure.

The launch window for a HTO to arrive at Mars' orbit near perihelion is only a few weeks long.



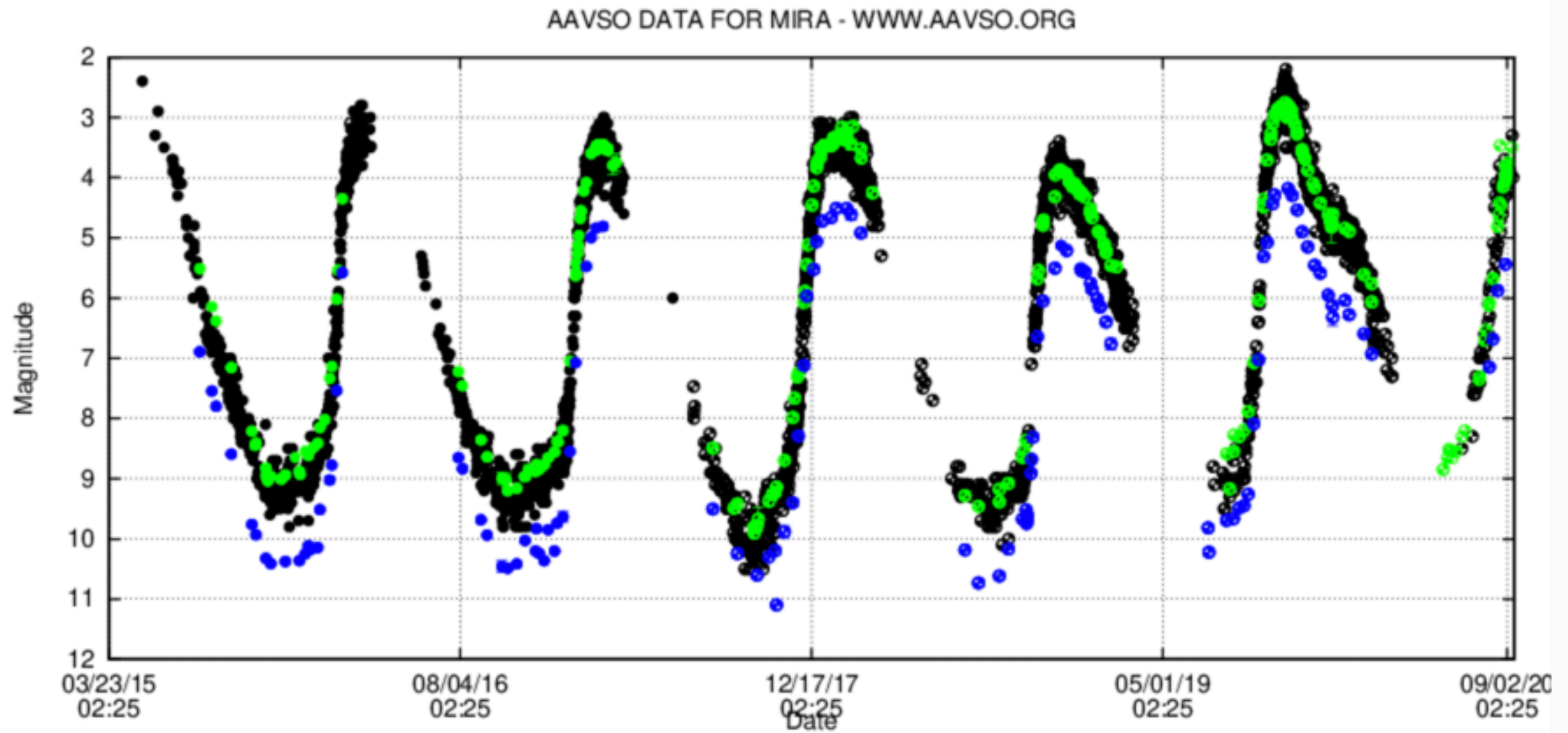
# Mira Near Mars



# Mira at Maximum

- Mira (Omicron Ceti) is the brightest and most famous long-period pulsating variable.
- Mira gave its name to a whole class of variable stars.
- Discovered as variable in 1596 by German pastor and astronomer David Fabricius.
- Magnitude varies 10.1 - 3.0, but maxima can be up to 2.0.
- At minimum, Mira is about as luminous as the Sun.
- At maximum, Mira increases its luminosity  $2.51^{(10.1 - 3.0)} = 688$  times.
- Period is ~332 days (about 11 months).
- Last maximum was 20 Oct 2019. Next one should be about 20 Sept 2020.

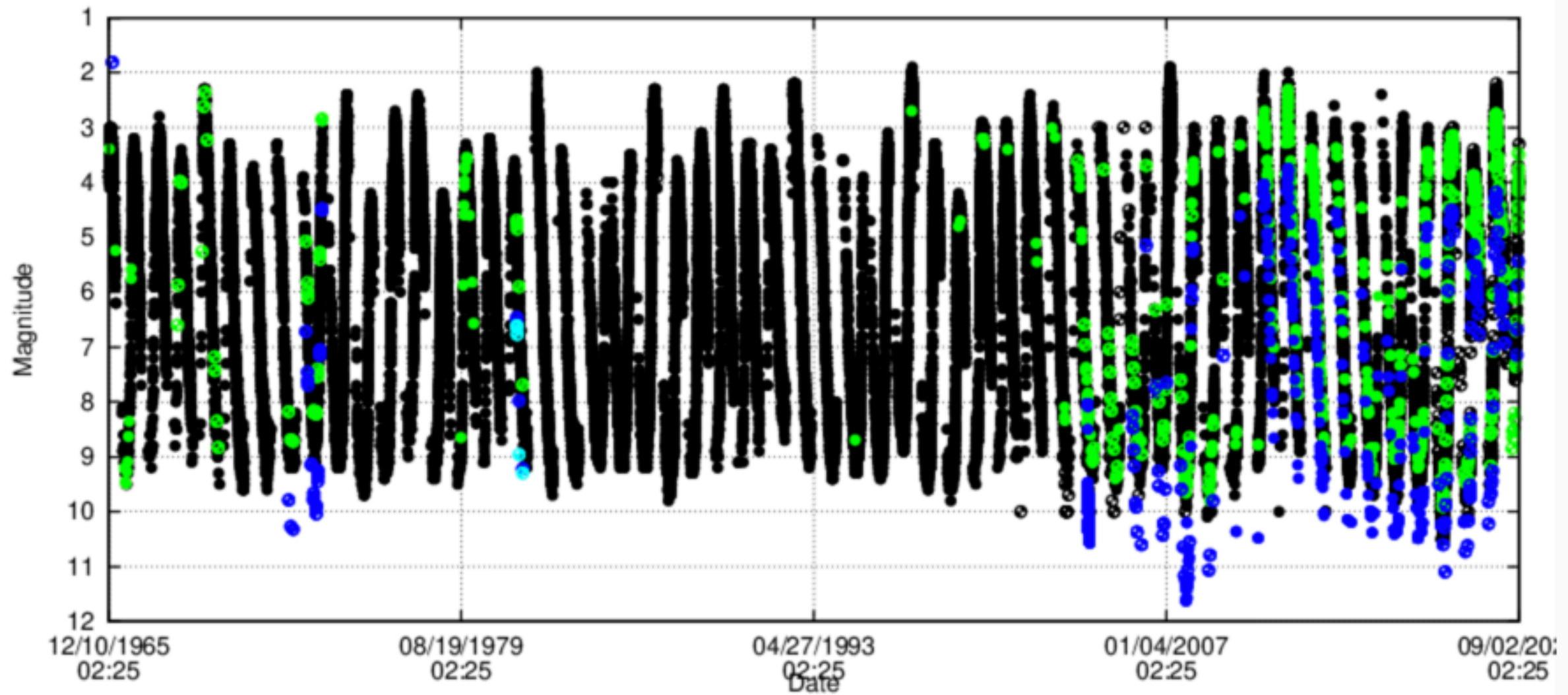
# 5-Year Mira Light Curve

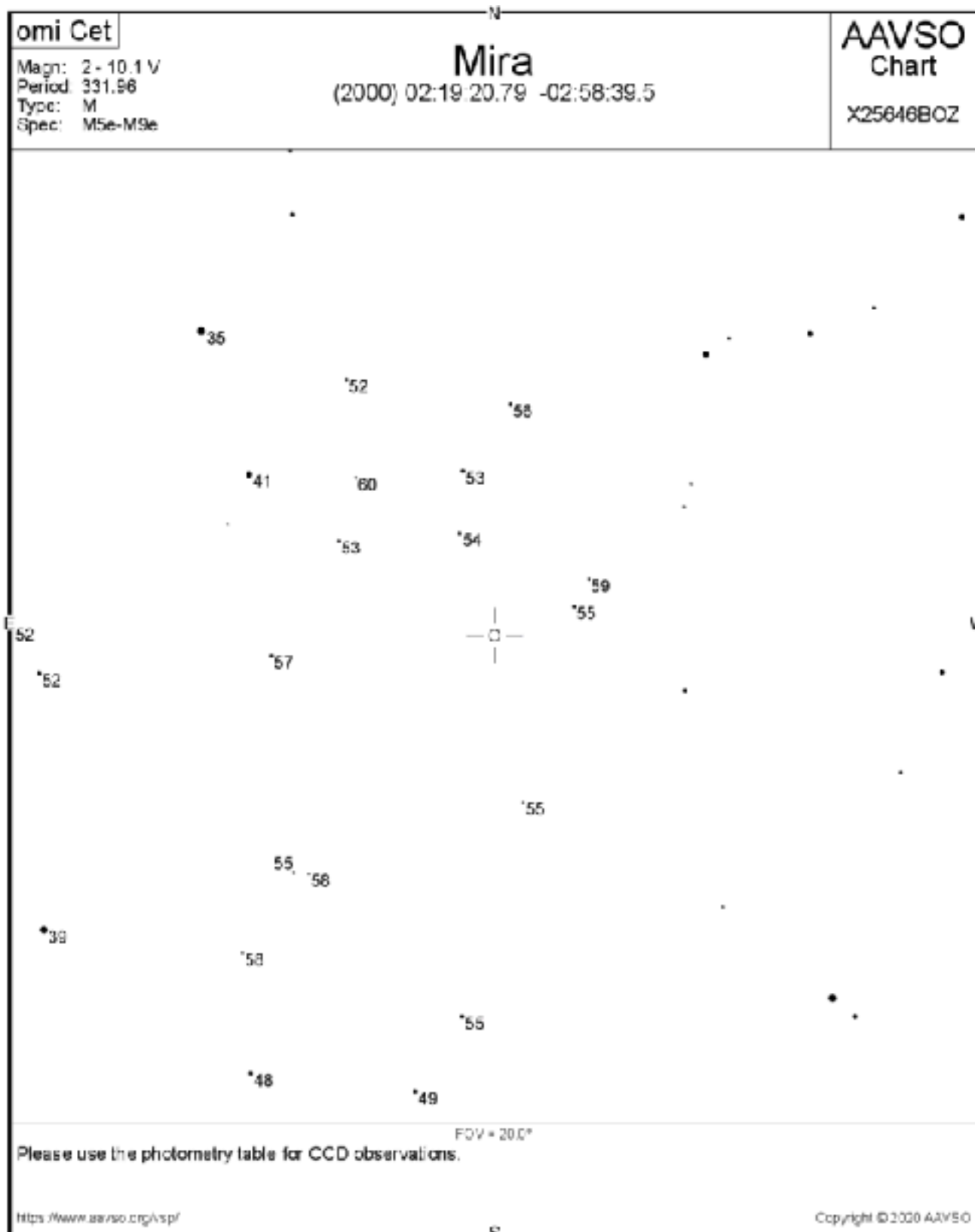




# 50-Yr Light Curve

AAVSO DATA FOR MIRA - WWW.AAVSO.ORG





- AAVSO Variable Star Plotter
- Gives magnitudes of stars close to Mira.

# Also ... Uranus & Neptune are Near Mars and Near Opposition

## Uranus

Magnitude: 5.7

Disk: 3.7"

Opposition: 10/31/2020

## Neptune

Magnitude: 7.8

Disk: 2.4"

Opposition: 11/11/2020

