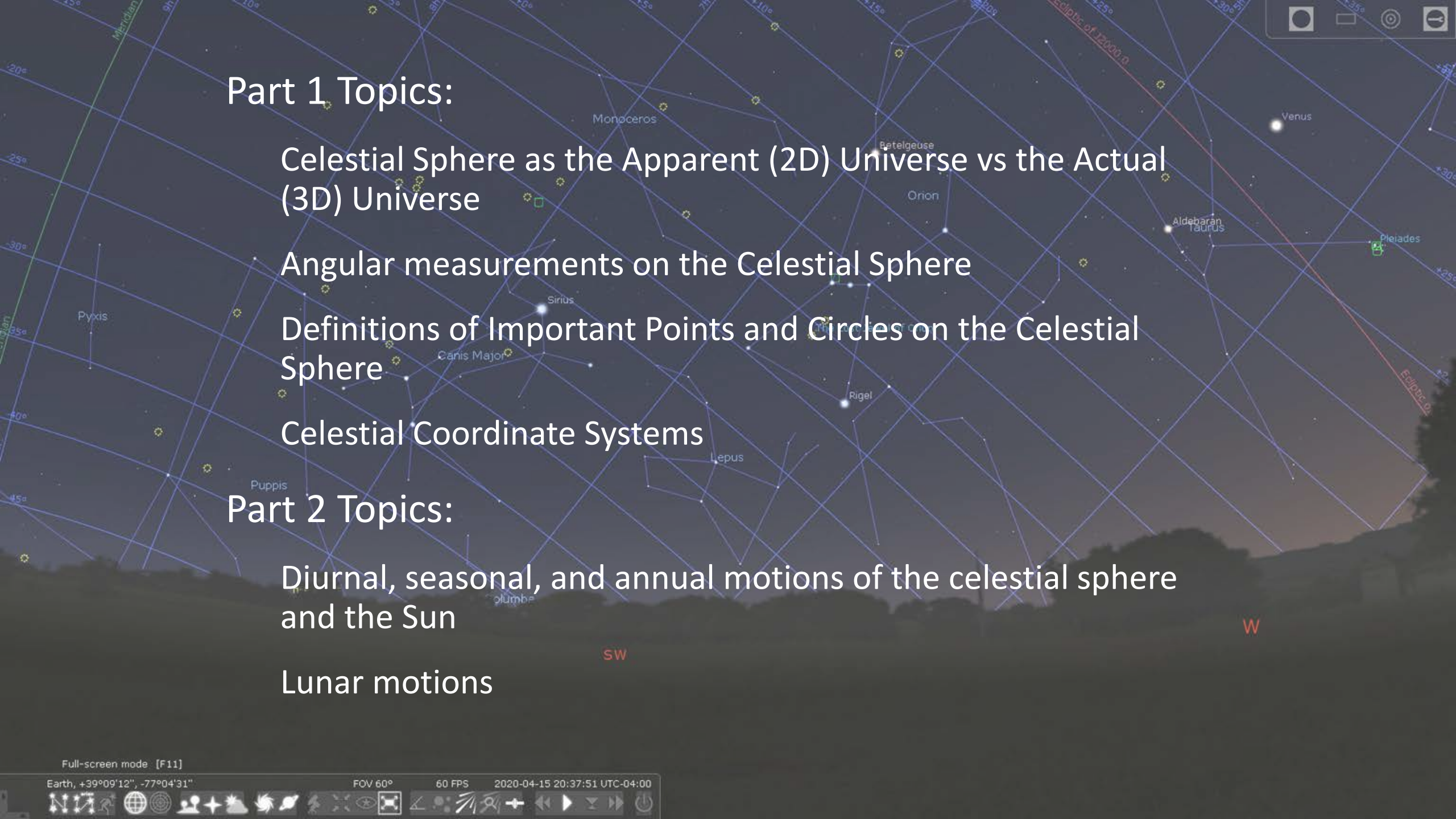
The Celestial Sphere

Part 3 – Planets

Jim Johnson
HAL Astro School
May 7, 2020

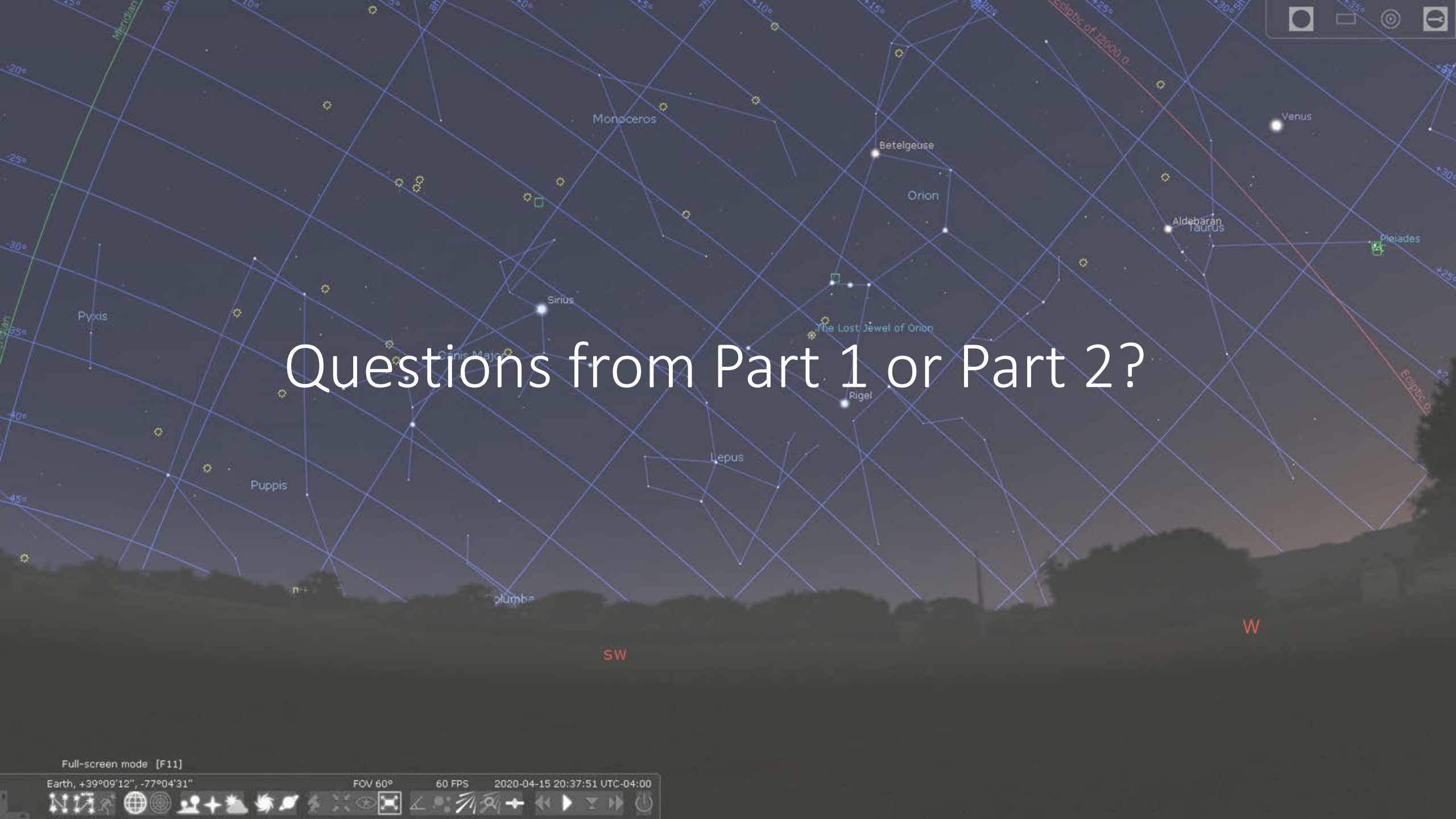


Part 1 Topics:

- Celestial Sphere as the Apparent (2D) Universe vs the Actual (3D) Universe
- Angular measurements on the Celestial Sphere
- Definitions of Important Points and Circles on the Celestial Sphere
- Celestial Coordinate Systems

Part 2 Topics:

- Diurnal, seasonal, and annual motions of the celestial sphere and the Sun
- Lunar motions



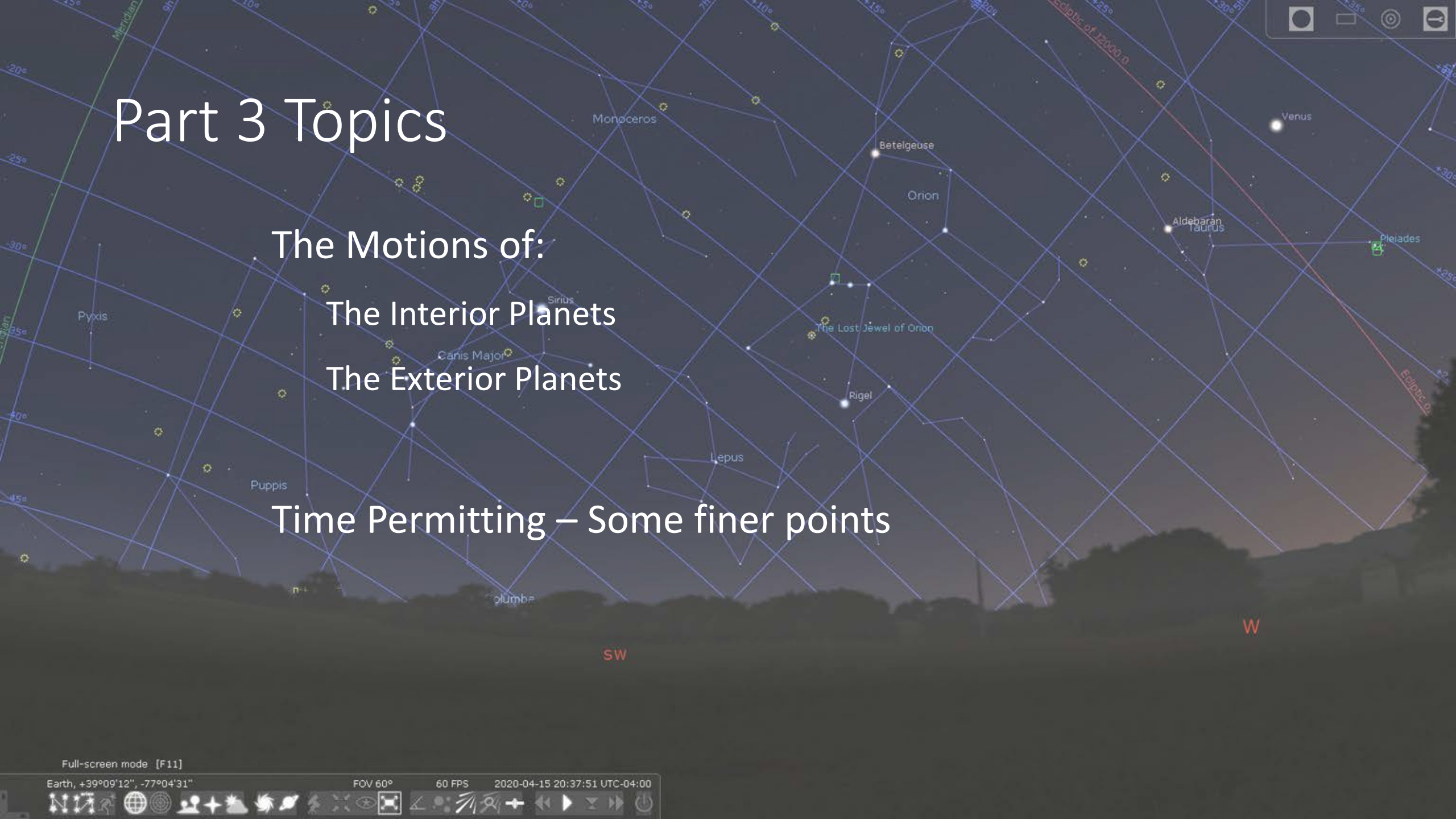
Questions from Part 1 or Part 2?

Part 3 Topics

The Motions of:

- The Interior Planets
- The Exterior Planets

Time Permitting – Some finer points



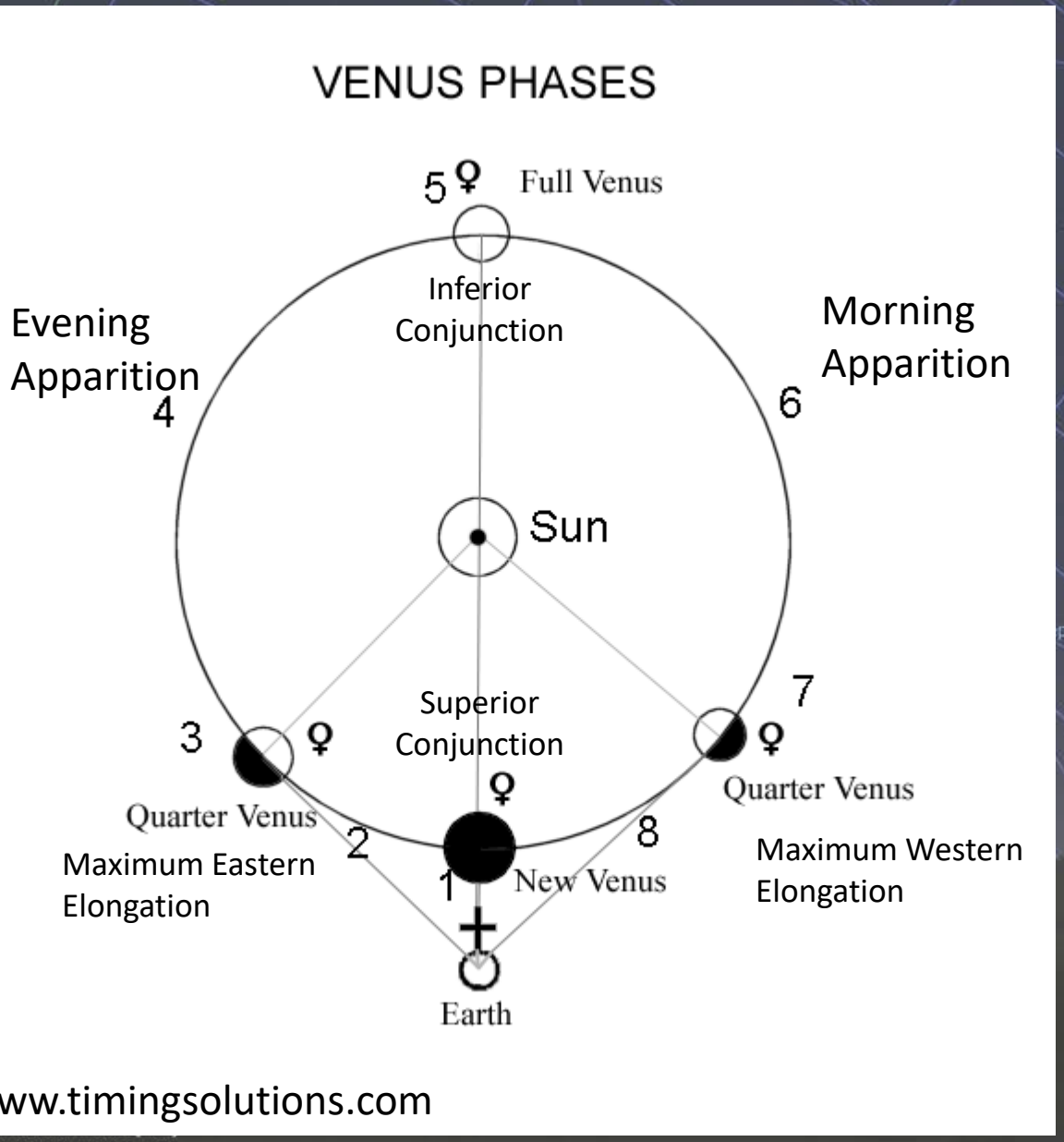
Periods – Sidereal vs. Synodic

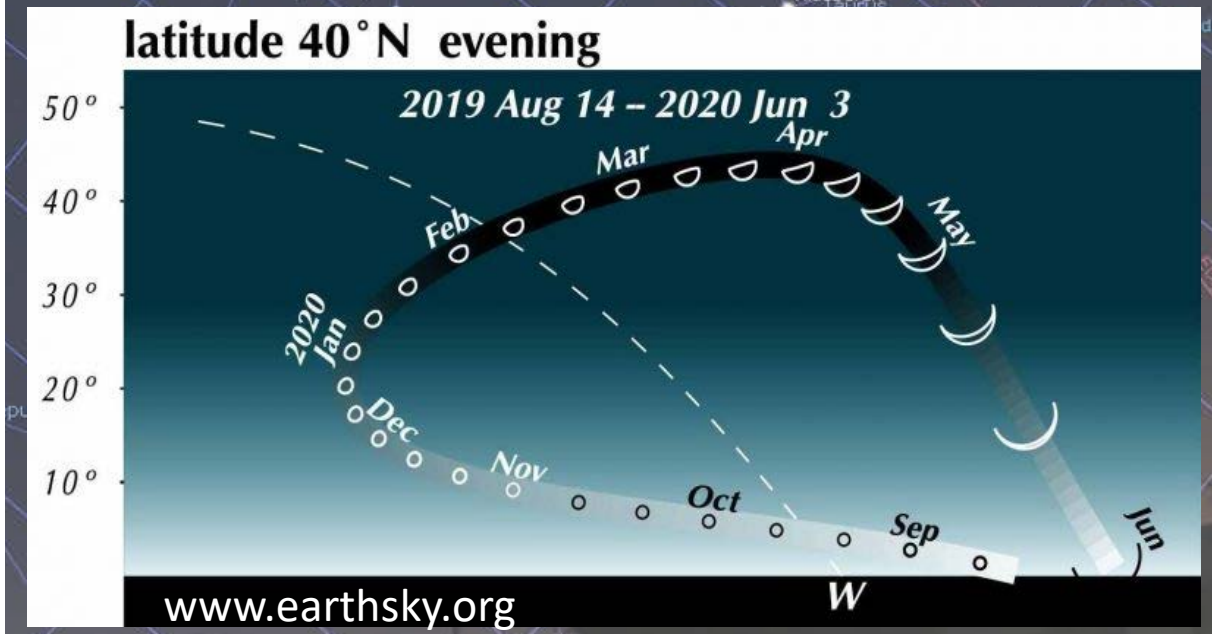
Sidereal– one orbit around the Sun with respect to the stars. View from Earth is irrelevant

Synodic – the period between two successive positions with respect to the Sun. View from Earth is relevant

Body	Sidereal Period	Synodic Period
Moon	27.3 days	29.5 days
Mercury	88 days	116 days
Venus	.6 years	1.6 years
Mars	1.9 years	2.1 years
Jupiter	11.9 years	1.1 years
Saturn	29.5 years	1.03 years

Venus





- Orbital period: 225 days
- Synodic period: 585 days
- Orbital distance: 67 million miles

Mercury

Similar to Venus except:

- Several apparitions each year. For the rest of 2020:

June 4, 2020	Evening
July 22, 2020	Morning
Oct 1, 2020	Evening
Nov 10, 2020	Morning

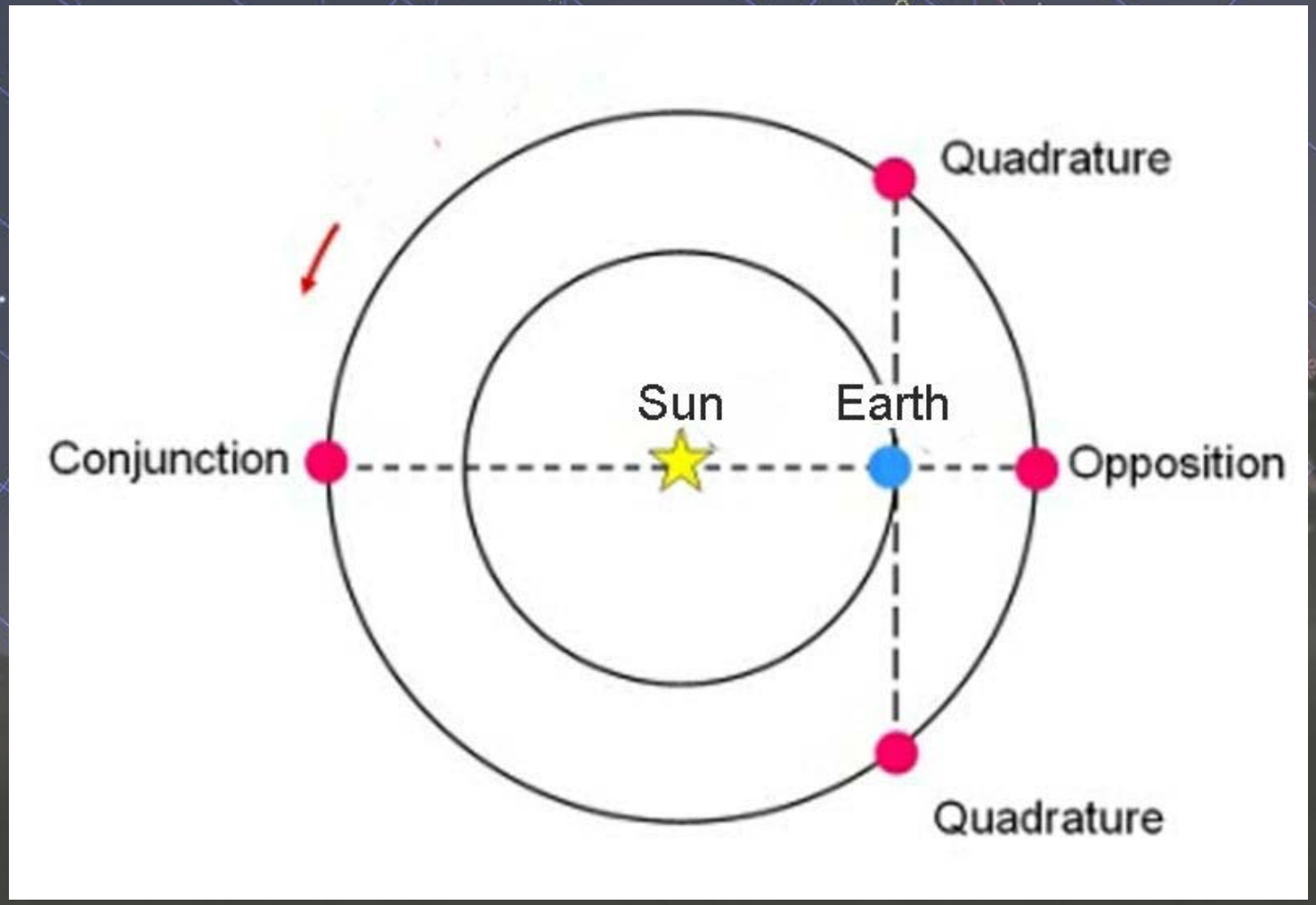
Note alternating pattern

- Only visible for a few days around greatest elongation
- Morning apparition: in east the 30-45 minutes before sunrise
- Evening apparition: in the west 30-45 minutes before sunset

Exterior Planet Alignments

Conjunction - Planet is:
- Aligned with Earth and Sun
- On the far side of the Sun
- At its farthest distance from Earth
- At its smallest angular diameter
- Is elongated 0° from the Sun
- Rising at sunrise
- Cannot be viewed

Opposition - Planet is:
- Aligned with Earth and Sun
- On the Earth side of the Sun
- At its nearest approach to Earth
- At is largest angular diameter
- Is elongated 180° from the Sun
- Rising at sunset
- Best viewing opportunity



Exterior Planets in 2020

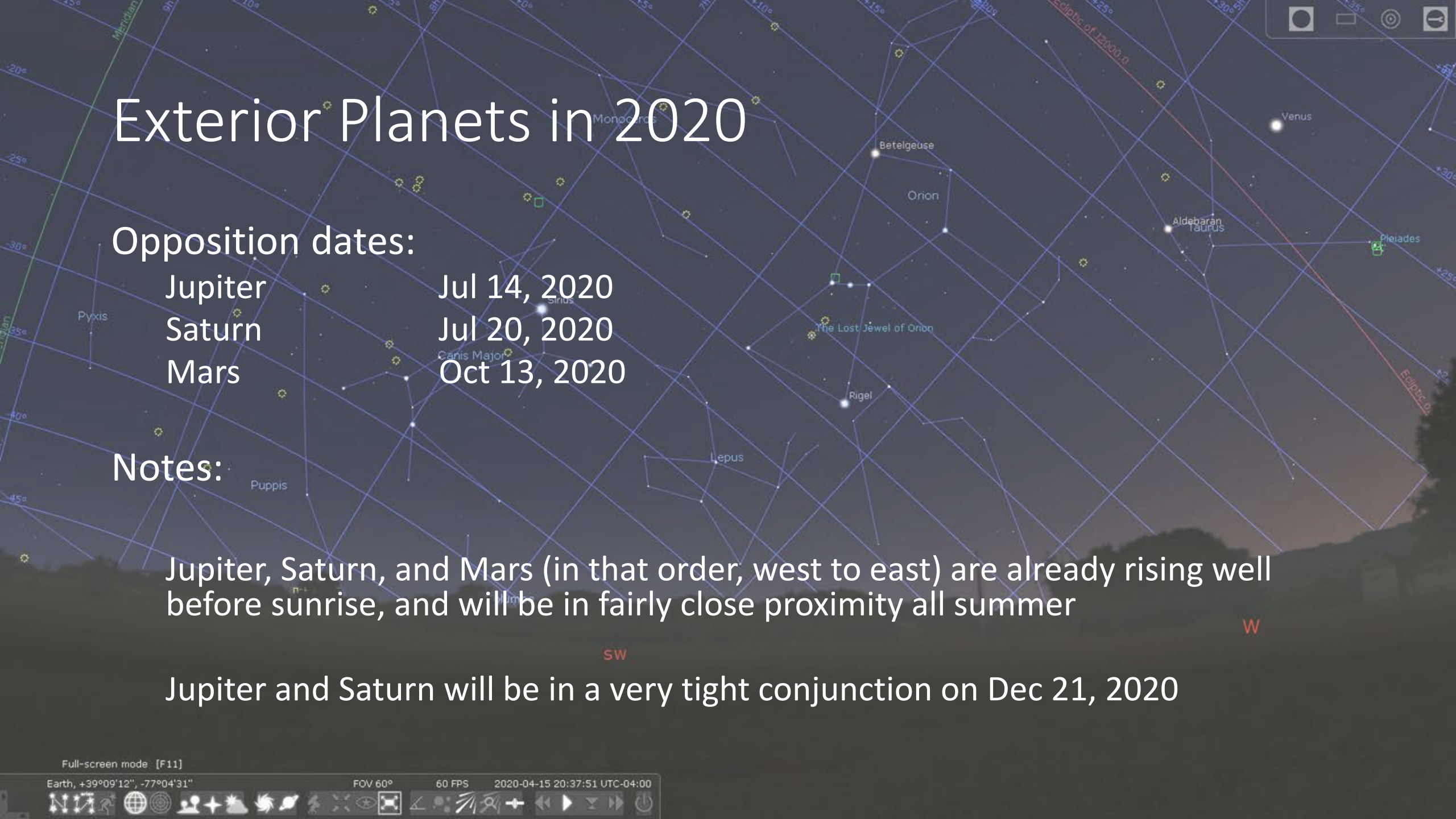
Opposition dates:

Jupiter	Jul 14, 2020
Saturn	Jul 20, 2020
Mars	Oct 13, 2020

Notes:

Jupiter, Saturn, and Mars (in that order, west to east) are already rising well before sunrise, and will be in fairly close proximity all summer

Jupiter and Saturn will be in a very tight conjunction on Dec 21, 2020

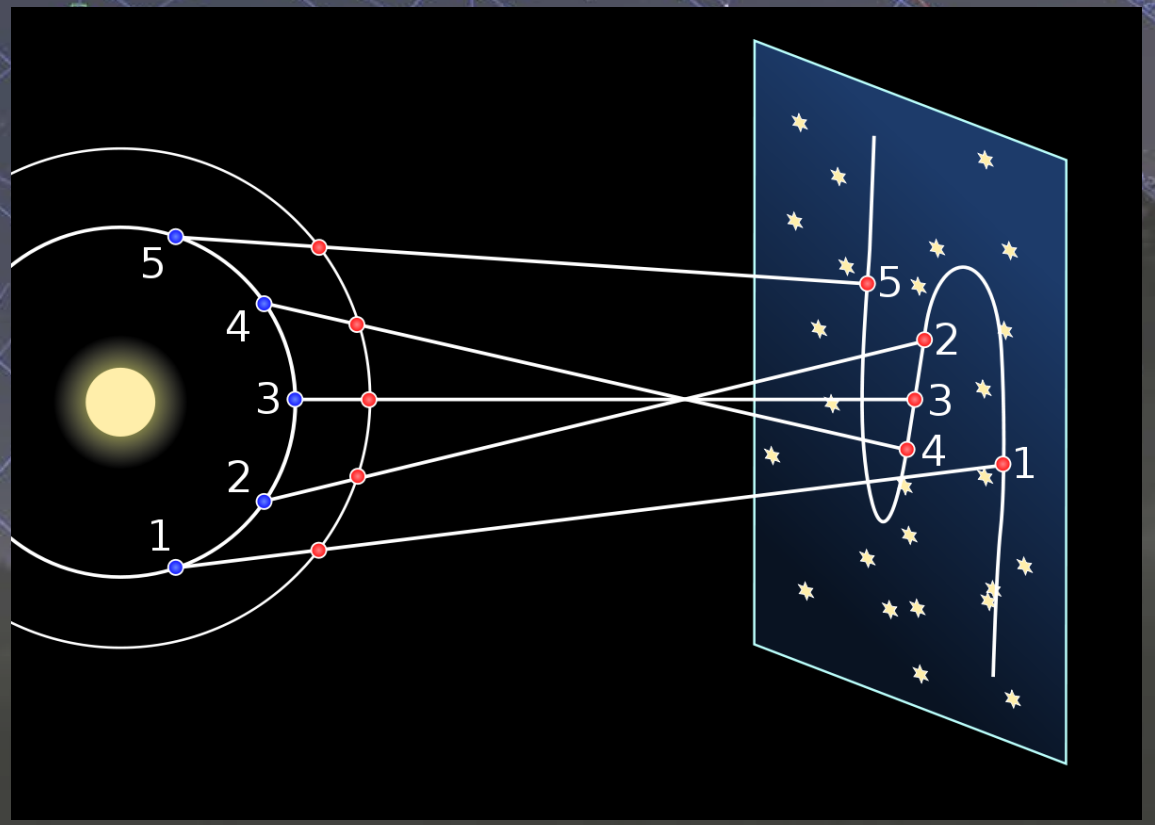


Prograde and Retrograde Motion

Prograde: A body's ordinary motion eastward along the ecliptic

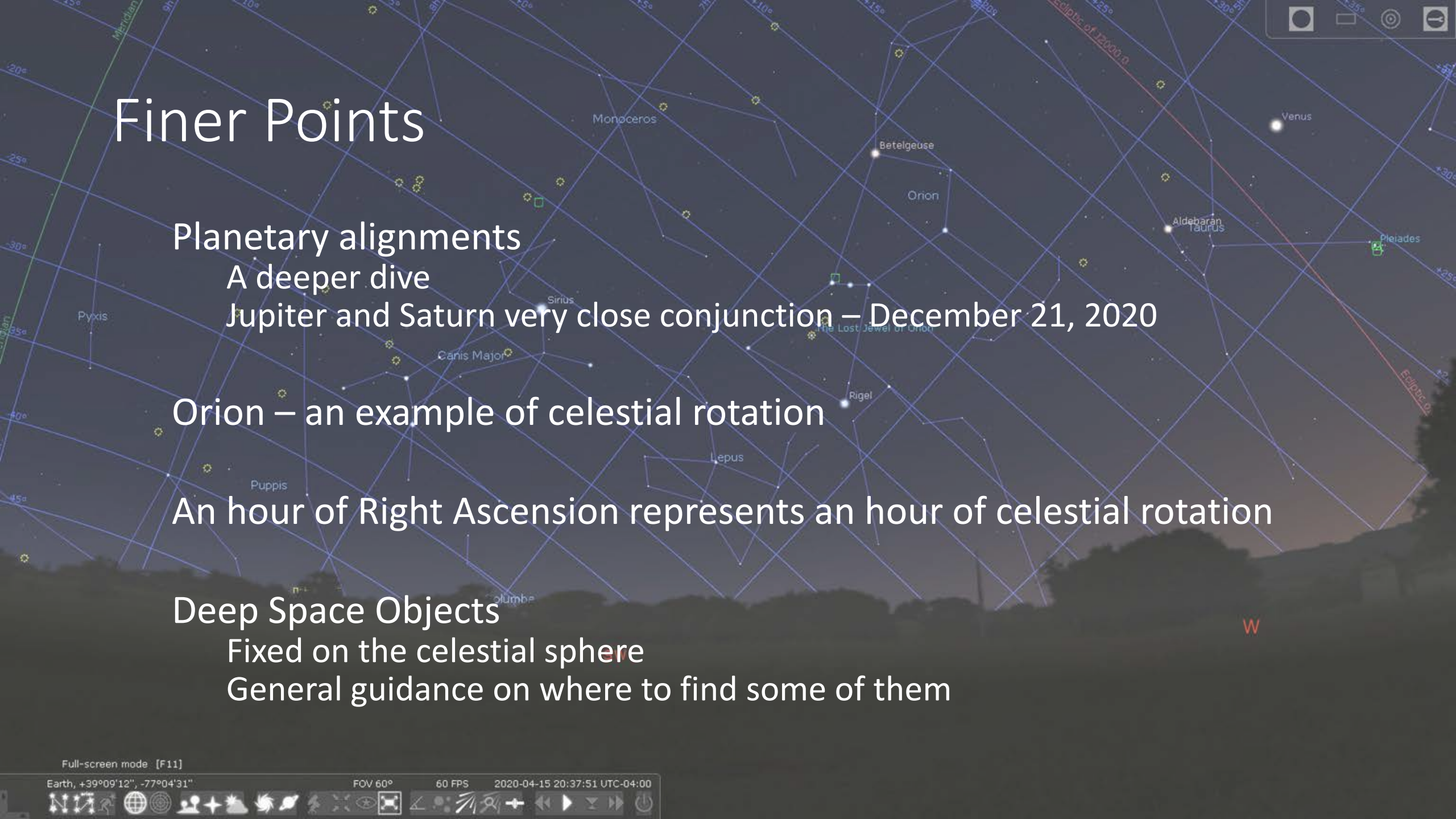
Retrograde: A body's westward motion

- Moon – does not apply. It is always prograde
- Interior Planets – from greatest eastward elongation to greatest westward elongation
- Exterior Planets – while Earth is "passing" the other planet around opposition



Finer Points

- Planetary alignments
  - A deeper dive
  - Jupiter and Saturn very close conjunction – December 21, 2020
- Orion – an example of celestial rotation
- An hour of Right Ascension represents an hour of celestial rotation
- Deep Space Objects
  - Fixed on the celestial sphere
  - General guidance on where to find some of them



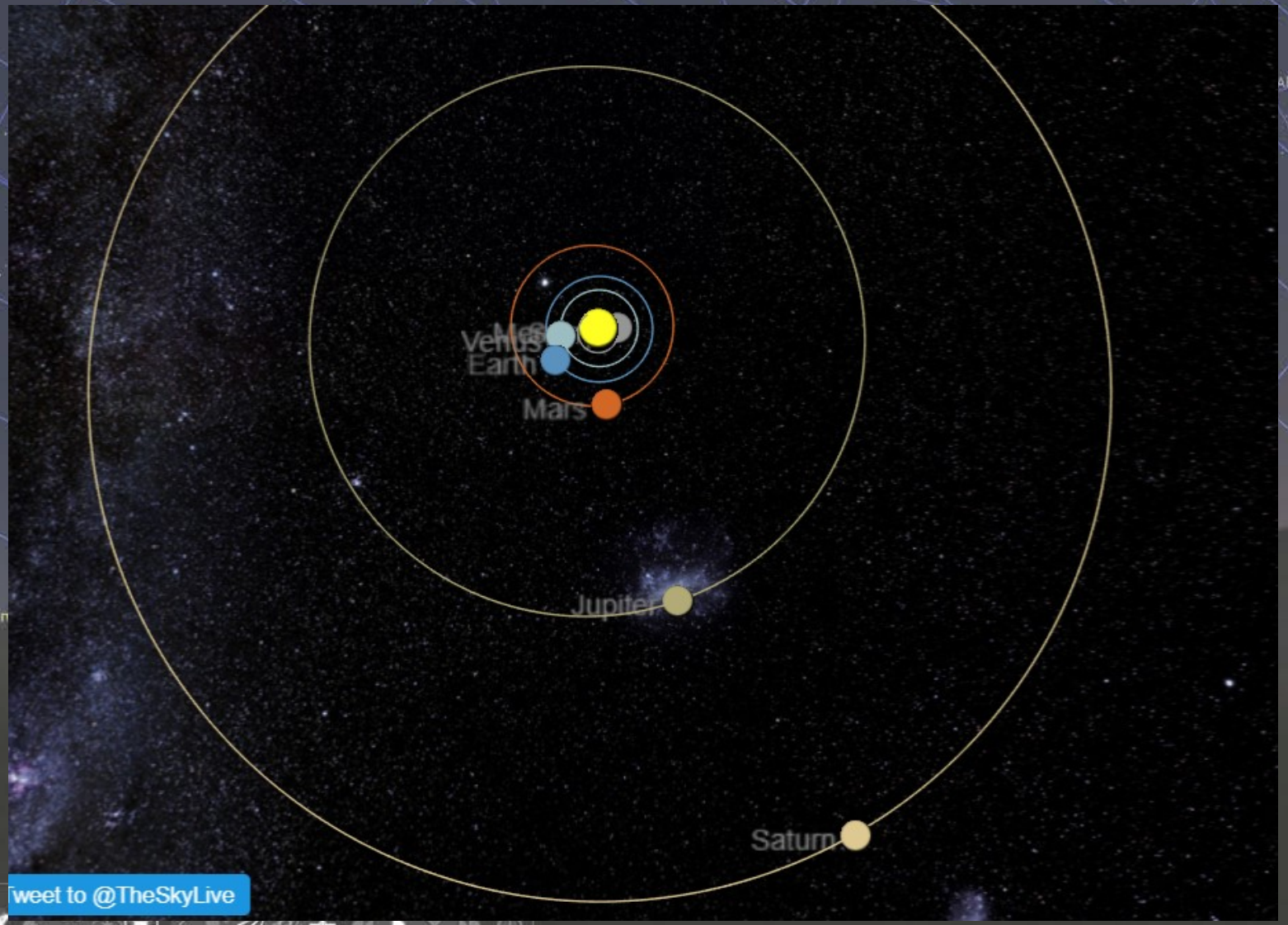
Date and Time

Date and Time | Julian Day

2020 – 5 – 5 | 5 : 1 : 42

Earth, Ashton, Maryland, 0 m | FOV 54.1° | 17.9 FPS | 2020-05-05 05:01:42 UTC-04:00

Solar System – Top Down View April 2020



Parting Words

Both the celestial sphere and planetarium apps are tools in the astronomer's tool kit. Just like all of the other tools, one must have a through understanding of how they work in order to use them effectively. Moreover, repetition and frequency of use are the best ways to build this understanding. Being able to use tools effectively will ease frustration and increase one's enjoyment of our hobby.

Clear skies!
Jim Johnson


Monoceros
Betelgeuse
Venus
Orion
Aldebaran
Taurus
Pleiades
Pyxis
Canis Major
Rigel
Lepus
Puppis
Ecliptic of J2000.0
W
SW
Full-screen mode [F11]
Earth, +39°09'12", -77°04'31"
FOV 60°
60 FPS
2020-04-15 20:37:51 UTC-04:00

Questions?