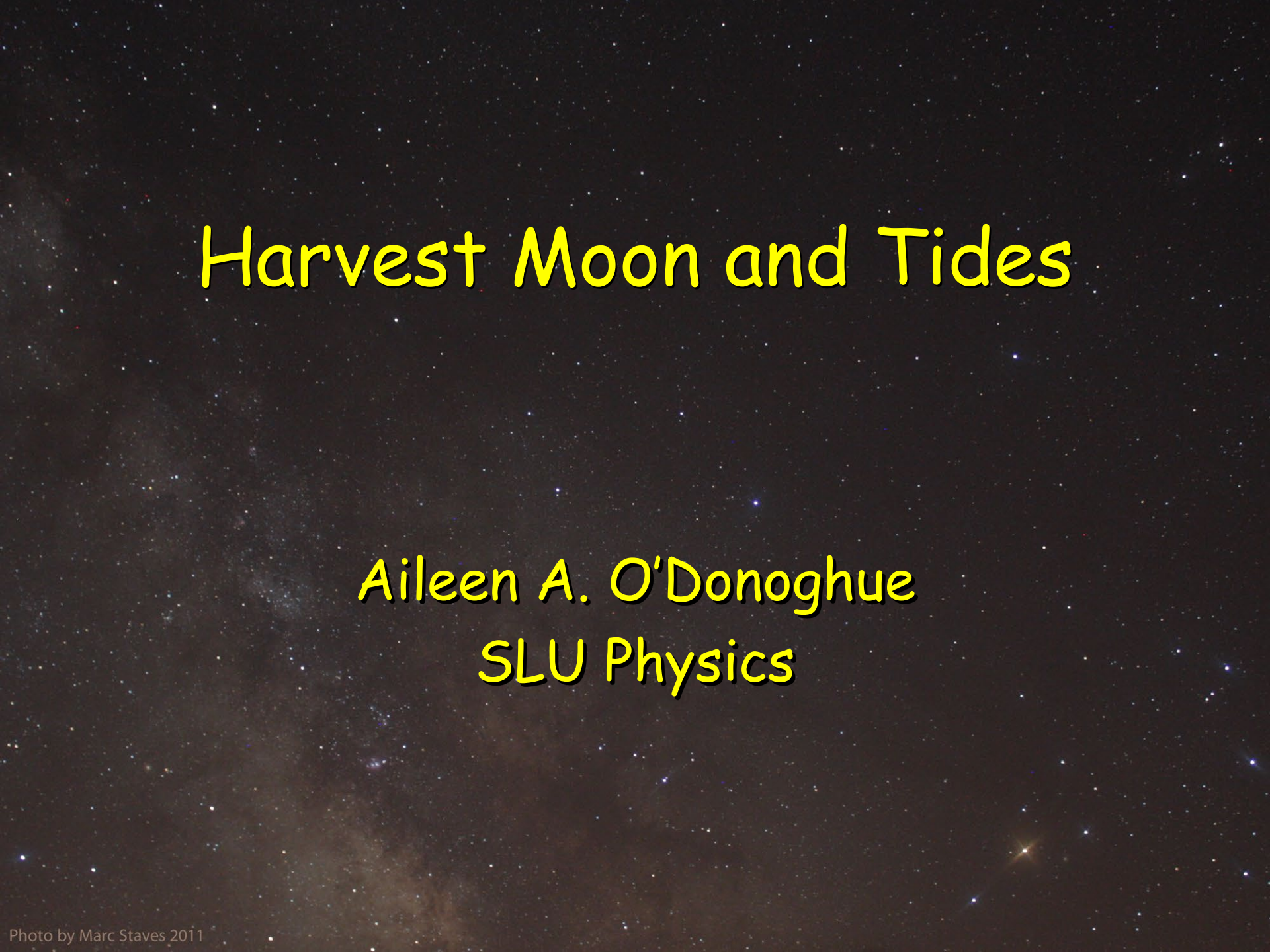
Harvest Moon and Tides

Aileen A. O'Donoghue
SLU Physics



Harvest Moon 2025

- ☆ Some full moons are named
  - 🌎 Harvest moon = full moon closest to equinox
    - ☽ September 29, 5:57 am EDT
      - ♈ Exact time of moon at elongation of 180°
    - ☽ Moon bright at rising for days
    - ☽ Allowed farmers to work into the night
  - 🌎 Hunter's moon = follows Harvest moon
    - ☽ October 28, 4:24 pm EDT
      - ♈ Exact time of moon at elongation of 180°

Photo by Marc Staves 2011

Harvest Moon 2023 Illustration

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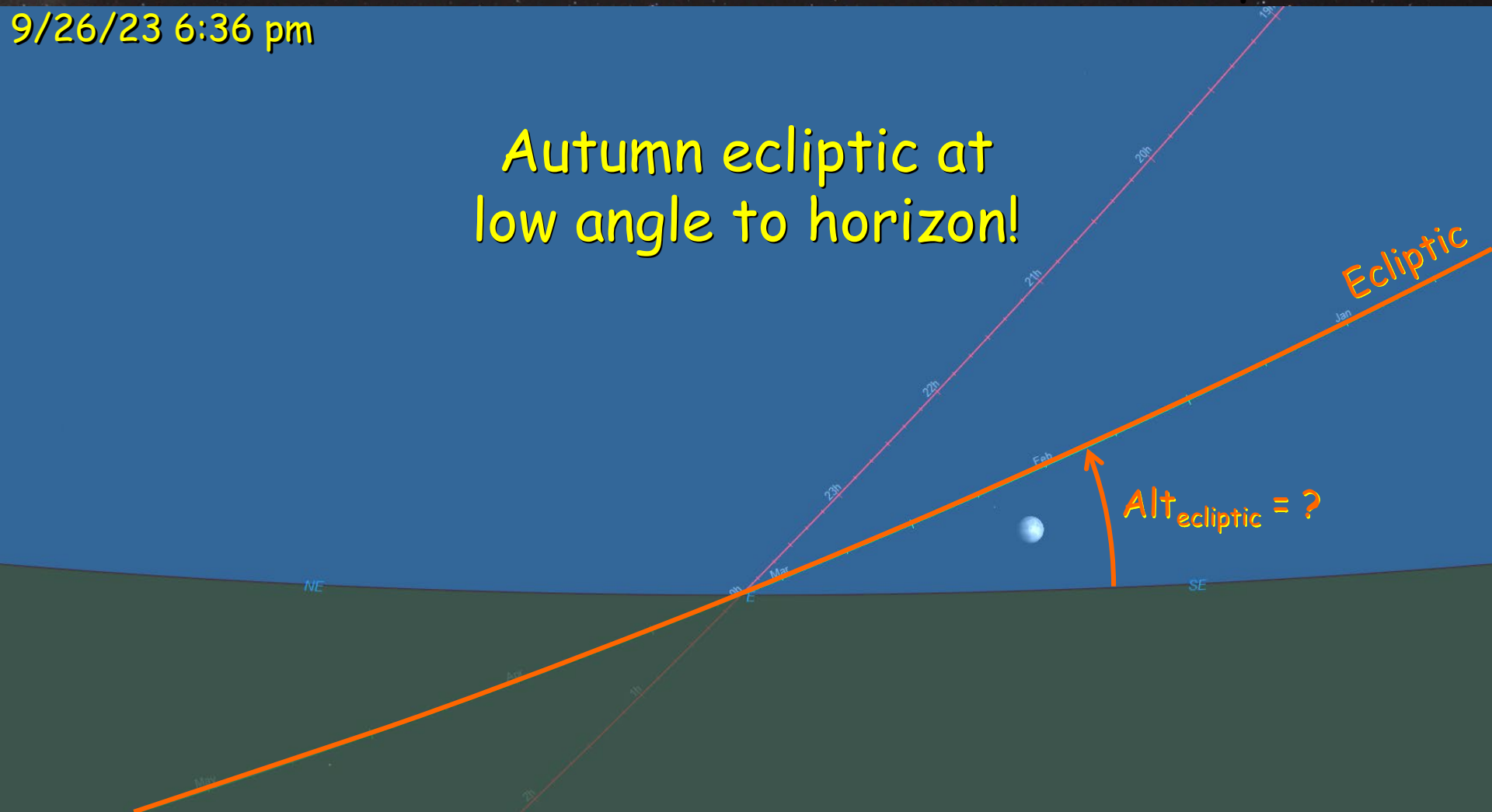


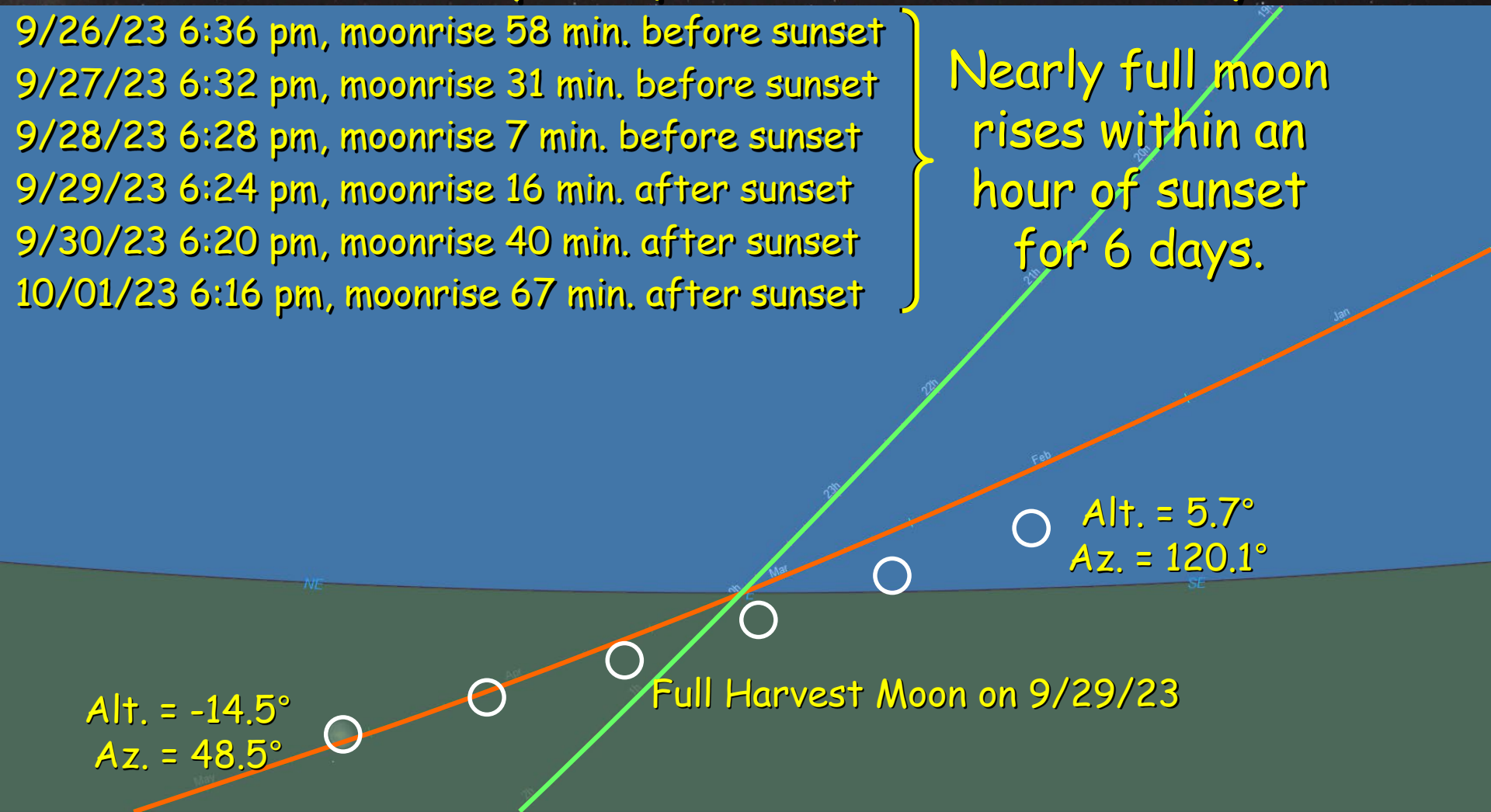
Harvest Moon 2023 Illustration

☆ Harvest Moon at sunset

🌎 Moon as Sept. Equinox rises over 6 days

9/26/23 6:36 pm, moonrise 58 min. before sunset
9/27/23 6:32 pm, moonrise 31 min. before sunset
9/28/23 6:28 pm, moonrise 7 min. before sunset
9/29/23 6:24 pm, moonrise 16 min. after sunset
9/30/23 6:20 pm, moonrise 40 min. after sunset
10/01/23 6:16 pm, moonrise 67 min. after sunset

Nearly full moon rises within an hour of sunset for 6 days.



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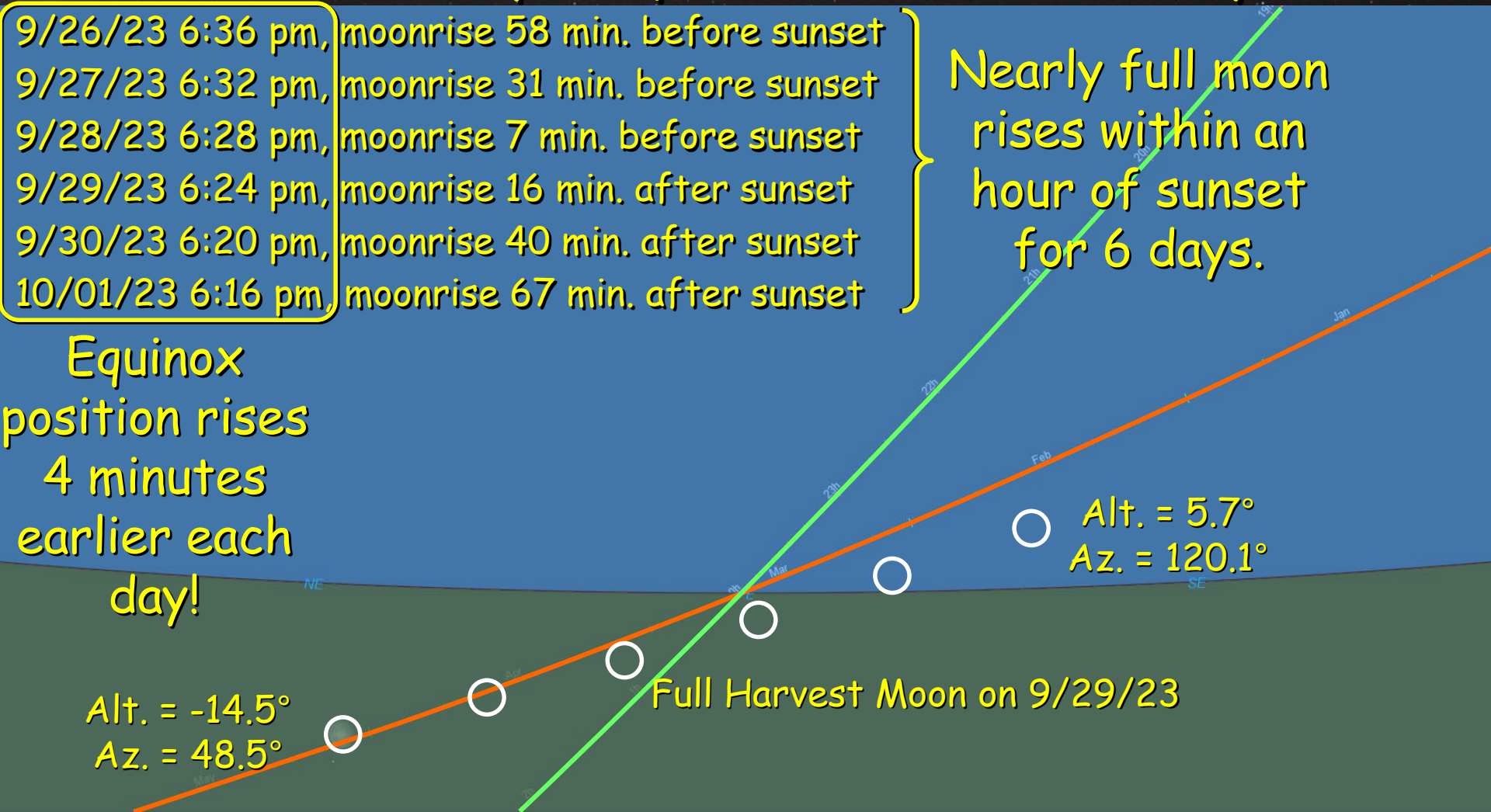
Equinox position rises 4 minutes earlier each day!



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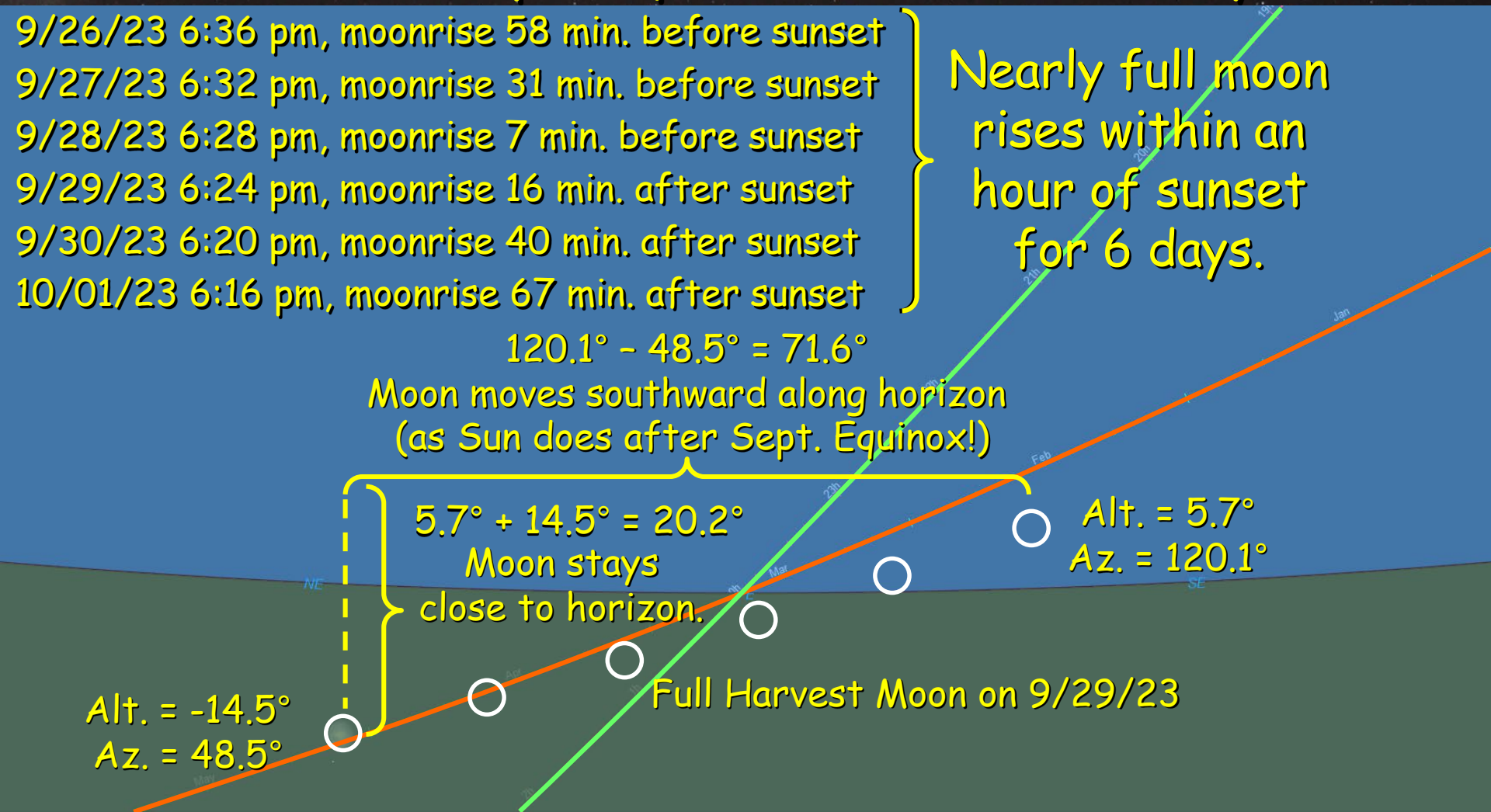


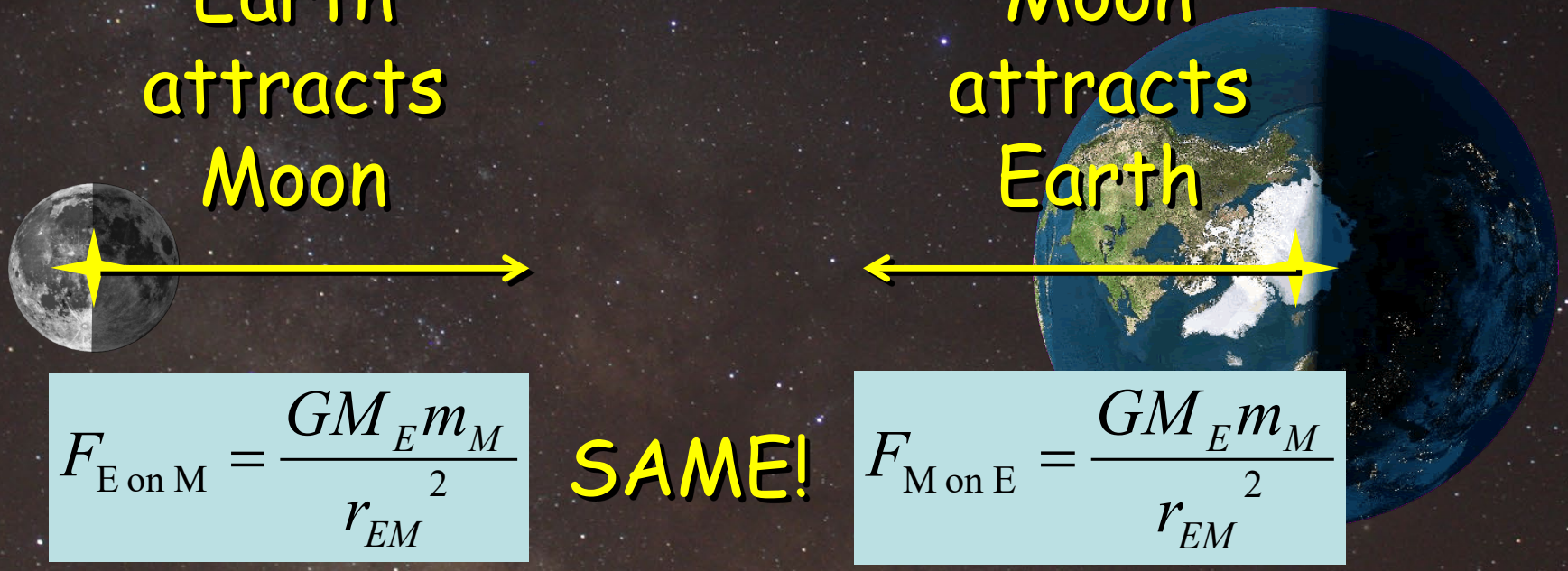
Tides

- Gravity
  - Depends on inverse of distance squared

$$F_G = \frac{Gm_1m_2}{r^2}$$

Earth attracts Moon

Moon attracts Earth



$$F_{\text{E on M}} = \frac{GM_Em_M}{r_{EM}^2}$$

SAME!

$$F_{\text{M on E}} = \frac{GM_Em_M}{r_{EM}^2}$$

Photo by Marc Staves 2011

Tides

- ☆ Gravity
  - Depends on inverse of distance squared
  - Differential gravity
    - ☽ Moon's pull stronger on near side of Earth than center or far side

$$F_G = \frac{Gm_1m_2}{r^2}$$

$$F_{\text{Near}} = \frac{GM_Em_M}{r_{\text{M to Near}}^2}$$

$$F_{\text{Center}} = \frac{GM_Em_M}{r_{\text{M to Center}}^2}$$

$$F_{\text{Far}} = \frac{GM_Em_M}{r_{\text{M to Far}}^2}$$

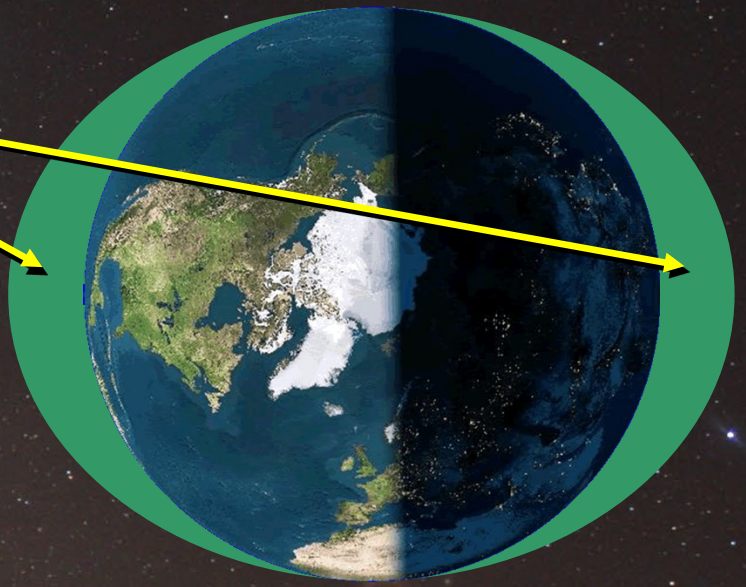
Photo by Marc Staves 2011

Tides

- ☆ Differential Gravity
  - Distorts Earth
    - ☽ Pulls near side toward
    - ☽ Pulls center less hard
    - ☽ Leaves far side behind

$$F_G = \frac{Gm_1m_2}{r^2}$$

Tidal bulges



But Earth rotates!

Tides

- ☆ Tidal Bulges
  - Earth rotates underneath
    - ☽ Lag behind sunlunar point

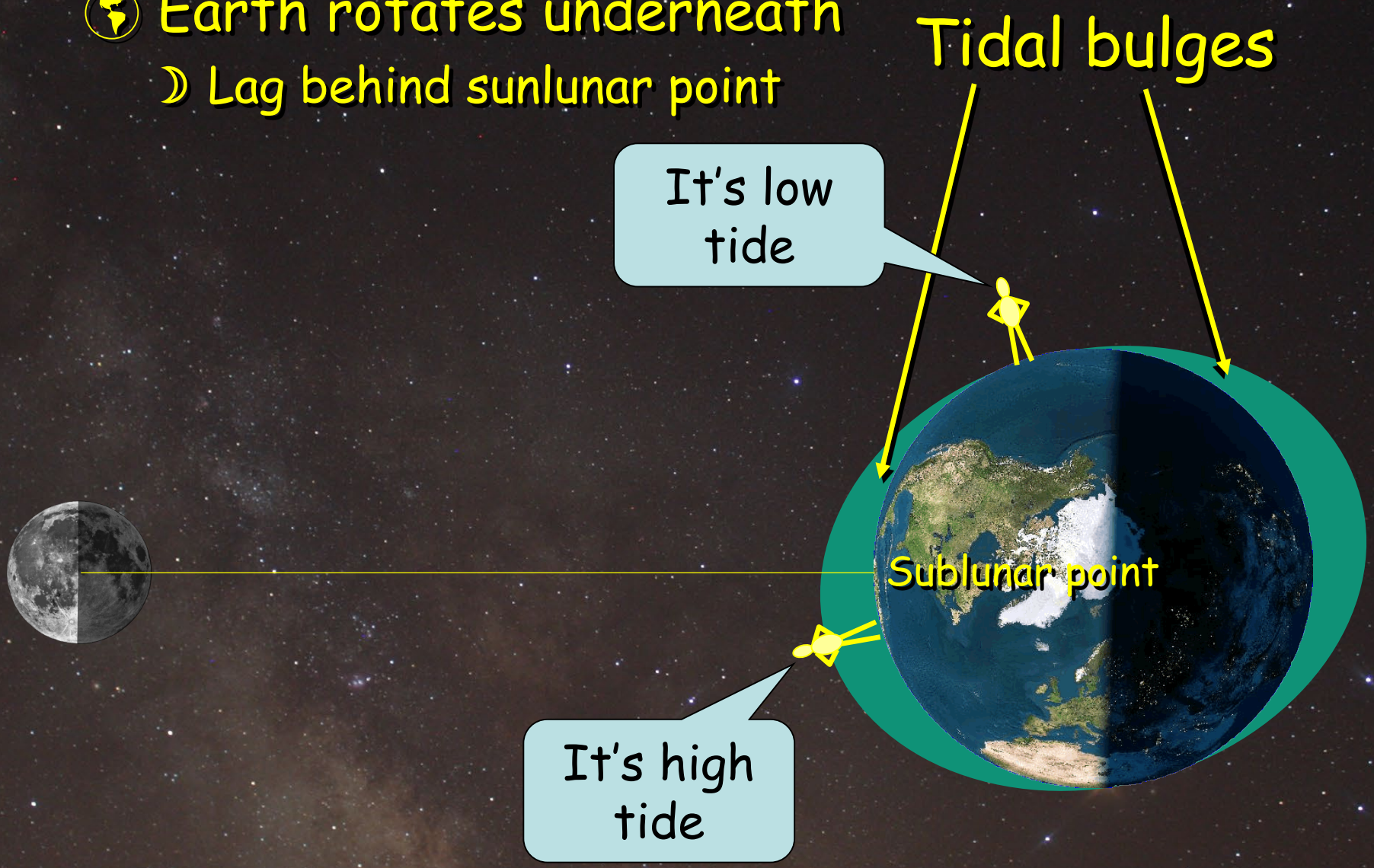


Photo by Marc Staves 2011

Tides

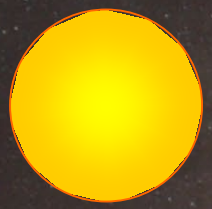
- ☆ Tidal Bulges
  - Slow Earth's rotation
    - ☽ Day lengthening by 1.4 ms each century
      - ♈ 4.5 billion years ago (moon formed), day 18 hours long
  - Speed Moon in its orbit
    - ☽ Moon is moving away at 3.82 cm/yr
      - ♈ 25% closer 3.2 billion years ago

Bulge attracts Moon

Moon attracts Bulge

Tides Caused by the Sun

- ☆ Sun much bigger, much farther away
  - 🌎 Tides add to Moon's
    - ☽ Spring Tides
      - ♈ Solar & Lunar tidal bulges add
      - ♈ New & Full moon

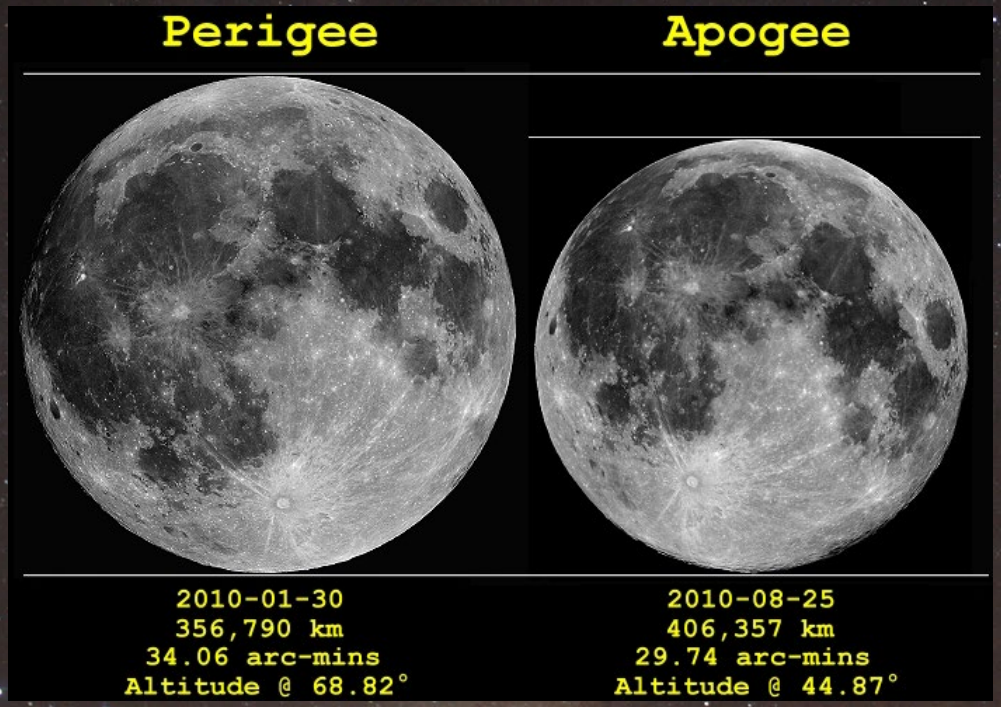


Tides Caused by the Sun

- ☆ Sun much bigger, much farther away
  - 🌎 Tides add to Moon's
    - ☽ Neap Tides
      - ♈ Solar & Lunar tidal bulges perpendicular
      - ♈ Quarter moons

King Tides

- ☆ King Tide = Spring Tide at Perigee
  - Apogee (micromoon) weakens lunar tides
  - Perigee (supermoon) strengthens lunar tides



https://epod.usra.edu/blog/2011/03/full-moon-comparison-of-2010.html

Photo by Marc Staves 2011

Lunar Perigee and Apogee Calculator

https://www.fourmilab.ch/earthview/pacalc.html

To display the date, time, and distance of lunar perigees and apogees for a given year, enter the year in the box below and press "Calculate". Depending on the speed of your computer, it may take a while for the results to appear in the text boxes. This page requires your browser to support JavaScript, and that JavaScript be enabled; all computation is done on your own computer so you can, if you wish, save this page in a file and use it even when not connected to the Internet.

Year: 2025 Calculate Previous year Next year

Perigees and Apogees

Perigee				Apogee			
Jan	7 23:36	370171 km	F-5d22h	Jan 21	4:56	404298 km	F+7d 6h
Feb	2 2:44	367456 km	N+3d14h	Feb 18	1:12	404881 km	F+5d11h
Mar	1 21:20	361966 km	N+1d20h	Mar 17	16:38	405752 km	F+3d 9h
Mar	30 5:27	358126 km	N+ 18h	Apr 13	22:49	406294 km +	F+ 22h
Apr	27 16:16	357118 km -	N- 3h	May 11	0:50	406244 km +	F-1d16h
May	26 1:38	359022 km	N-1d 1h	Jun 7	10:44	405551 km	F-3d21h
Jun	23 4:44	363176 km	N-2d 5h	Jul 5	2:30	404626 km	F-5d18h
Jul	20 13:54	368046 km	N-4d 5h	Aug 1	20:38	404163 km	F-7d11h
Aug	14 18:02	369286 km	F+5d10h	Aug 29	15:35	404551 km	N+6d 9h
Sep	10 12:11	364780 km	F+2d18h	Sep 26	9:47	405551 km	N+4d13h
Oct	8 12:37	359818 km	F+1d 8h	Oct 23	23:32	406444 km -	N+2d11h
Nov	5 22:30	356832 km ++	F+ 9h	Nov 20	2:49	406692 km --	N- 3h
Dec	4 11:07	356961 km +	F- 12h	Dec 17	6:11	406322 km -	N-2d19h

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New moons near perigee

Full moons near perigee

King Tides, Mar.-Apr. and Nov.-Dec. 2025

New and Full Moons

☆ King

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https://epod.usra.edu/

Photo by Marc Staves 2011

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Apogee

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:32 406444 km - N+2d11h
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New and Full Moons

New	Full
2024 Dec 30 22:28	2025 Jan 13 22:28
2025 Jan 29 12:37	2025 Feb 12 13:54
2025 Feb 28 0:47	2025 Mar 14 6:56
2025 Mar 29 11:00	2025 Apr 13 0:24
2025 Apr 27 19:33	2025 May 12 16:58
2025 May 27 3:04	2025 Jun 11 7:46
2025 Jun 25 10:34	2025 Jul 10 20:39
2025 Jul 24 19:12	2025 Aug 9 7:57
2025 Aug 23 6:07	2025 Sep 7 18:11
2025 Sep 21 19:55	2025 Oct 7 3:49
2025 Oct 21 12:26	2025 Nov 5 13:20
2025 Nov 20 6:48	2025 Dec 4 23:15
2025 Dec 20 1:44	2026 Jan 3 10:04

New and Full Moons

:11 406322 km - N-2d19h

Photo by Marc Staves 2011

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☆ King

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New and Full Moons

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Hunter's and Cold Moons are super moons with perigee 9 hours after or 12 hours before full moon!

Jun 23 4:44 363176 km N-2d 5h

Nov 5 22:30 356832 km ++ F+ 9h

Dec 4 11:07 356961 km + F- 12h

King Tides, Mar.-May and Oct

2010-01-3

356,790 k

34.06 arc-m

Altitude @ 6

https://epod.usra.edu/

Photo by Marc Staves 2011

:11 406322 km - N-2d19h

New and Full Moons