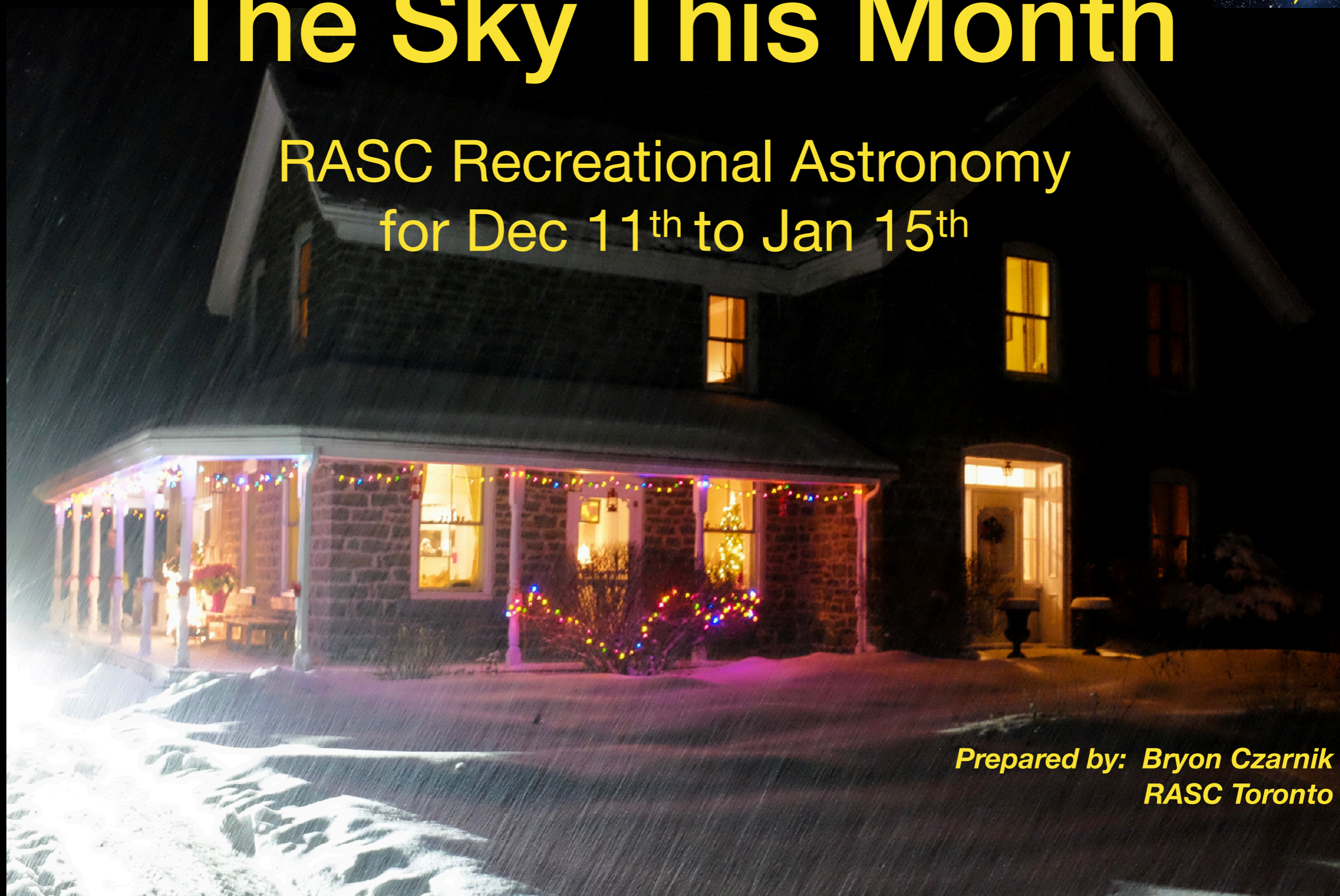




The Sky This Month

RASC Recreational Astronomy
for Dec 11th to Jan 15th



*Prepared by: Bryon Czarnik
RASC Toronto*

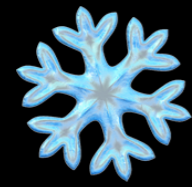


The Sky This Month

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☾ for Dec 11th to Jan 15th

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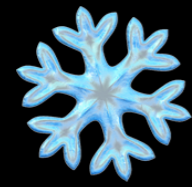
Holiday Astro Calendar



December 2019

< Today >

| | Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|---|------------------------------------|--|--------------------------------------|-----------------------------|------------------------------|---|------------------------------------|
| 50 | Sunrise / Sunset (Daylight) | | Astronomical Twilight (Night) | | | | |
| Dec 11 | 7:40 am / 4:40 pm (9:00) | | 6:24 pm / 5:57 am (11:33) | | | | |
| Jan 15 | 7:48 am / 5:05 pm (9:18) | | 6:46 pm / 6:06 am (11:20) | | | | |
| | | | | | Cold Moon 12:12 am | Final Full Moon of Decade: On 12th day of 12th month at 12:12 | |
| 51 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| | | Moon Perigee 370,265 km 3:00 pm | | Last Qtr 11:57 pm | | Winter Solstice 11:19 pm [8 hr 55 min 🕶️] | |
| 52 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| | | | Christmas Day | Boxing Day | New Moon 12:13 am | Annular Solar Eclipse | |
| 1 | 29 | 30 | 31 | Jan 1 | 2 | 3 | 4 |
| | | Moon Apogee 404,580 km 9:00 pm | | New Year's Day | First Qtr 11:45 pm | | Penumbral Lunar Eclipse |
| 2 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Earth Perihelion 147,091,144 Km | | | | | | Wolf Moon 2:21 pm | |
| 3 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| | | Moon Perigee 365,958 km 3:00 pm | | | | Last Qtr 7:58 am | |



Holiday Astro Calendar



December 2019

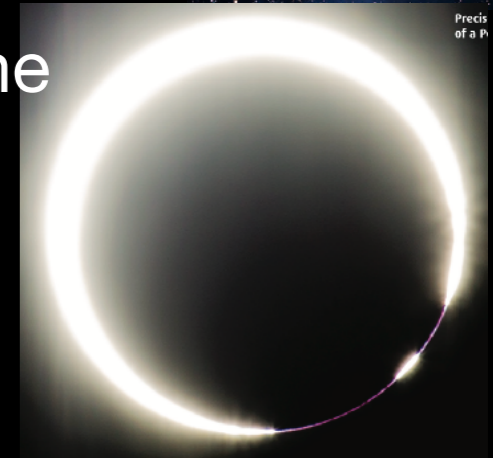
< Today >

| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|--|--|--|---|---|---|--|
| 50 8 John Glenn d. 2016 @ 95 yr | 9 | 10 Venus 2° S of Saturn 6:00 pm (7° Alt @ SW) | 11 Cold 🥶 Moon 12:12 am H. Leavitt d. 1921 @ 53 yr Cepheids | 12 Russell Porter b. 1871 Stellafane | 13 Geminids [peak 7pm] T. Brahe d. 1546 | 14 |
| 51 15 Moon 5° W of Beehive (M44) 3:00 am | 16 Moon Perigee 370,265 km 3:00 pm Proj Blue Book closed 1969 | 17 Last Qtr 11:57 pm | 18 Apollo 17 last to Moon 1972 | 19 Winter Solstice 11:19 pm C. Sagan d. 1996 | 20 Apollo 8 1st to Moon 1968 | 21 |
| 52 22 Ursids [peak 10pm] | 23 Mars 5.5° NW of @ 6:00 am (10° Alt @ E) | 24 Christmas Day Isaac Newton b. 1642 | 25 Boxing Day New 🌑 12:13 am | 26 Annular Solar Eclipse J. Kepler b. 1571 | 27 Venus 2.5° N of 6:00 pm (10° Alt @ SW) | 28 |
| 1 29 | 30 | 31 Moon Apogee 404,580 km 9:00 pm | Jan 1 New Year's Day | 2 First Qtr 11:45 pm | 3 Quadrantids [peak 3pm] Spirit 2004 1st Mars Rover | 4 |
| 2 5 Earth Perihelion 147,091,144 Km | 6 LRO Launched 1998 | 7 | 8 | 9 C. Herschel d. 1848 @ 97 yr | 10 Wolf 🐺 Moon 2:21 pm | 11 Moon 1° from Beehive (M44) 7:00 pm |
| 3 12 | 13 Moon Perigee 365,958 km 3:00 pm | 14 | 15 | 16 Penumbral Lunar Eclipse | 17 Last Qtr 7:58 am | 18 |

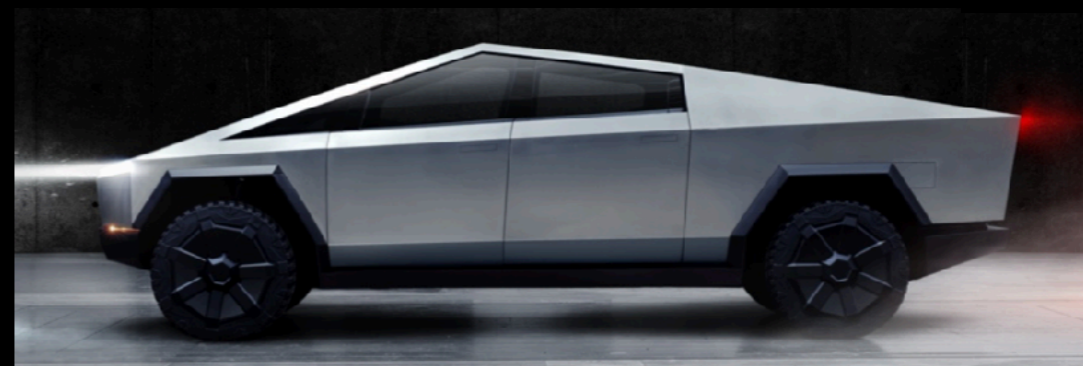
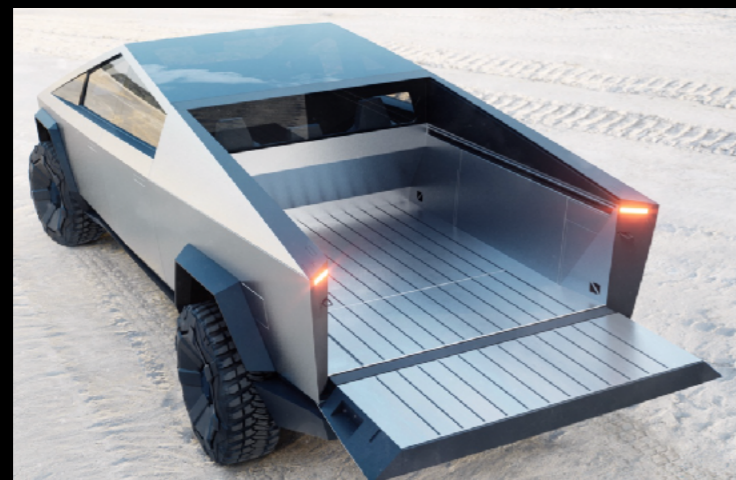
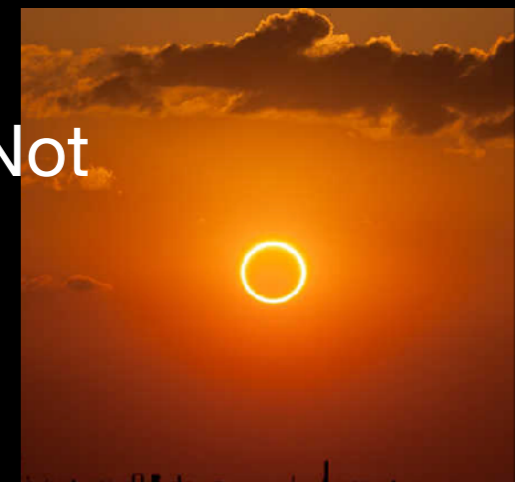
Solar System this Month



- Naked eye planets cluster by the Sun ... so lets celebrate the Sun?
 - **Annular Solar Eclipse** (Dec 26th) over South East Asia (max'm duration: 3' 40"; magnitude: 97%)
- **Mercury** is closing in on the Sun (Jan 10). Tough to catch. Only 6° above horizon ½ hr before sunrise this week
- **Mars** now rises at 5am and is moving away from the Sun. Not much to look at (4.4"), but wait until Oct opposition (22")
 - On Dec 12th, just 13' N of Zubenelgenubi (α Libra) in SE



Feb 26, 2017 3rd Contact
Source: JRASC Jun 2017
Stephen Beddingfield

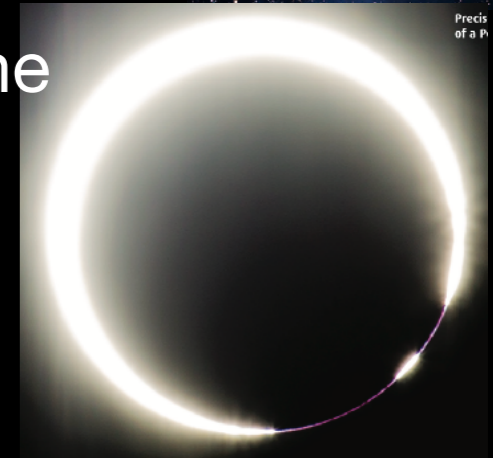


Elon Musk: "Tesla Cybertruck (pressurized edition) will be official truck of Mars."

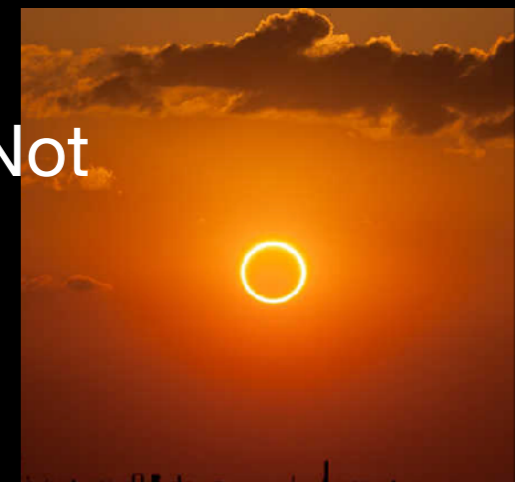
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 - On Dec 12th, just 13' N of Zubenelgenubi (α Libra) in SE
- **Venus** is moving away from the Sun all month, rising higher each evening in the SW
 - On Dec 10th, Venus (-4 mag) and Saturn (0.6 mag) are within 2° and remain within 5° for the next 5 days
 - On Dec 18-19, within 1° of 9th mag globular M75 (Sgr)



Feb 26, 2017 3rd Contact
Source: JRASC Jun 2017
Stephen Beddingfield



Solar System this Month



- **Jupiter** is too close to the Sun. Conjunction with the Sun on Dec 27th
- **Saturn** is moving closer and closer to the Sun and a Jan 13th conjunction with it
- Blue-green **Uranus** (5.7 mag; 3.6") is high in the evening sky; in Aries near Pisces
- Binoculars can find blue **Neptune** (8 mag; 2.3") in Aquarius within same field as ϕ (Phi) Aqr (4 mag). By Dec 31st, separation is 1.1°
- **Moon** 2° below Venus on Dec 28th for 2 hr after sunset; also, lunar conjunction with Mars on Dec 22nd and Dec 23rd ;
 - (So so) nearly full moon in Beehive (M44) Dec 15th and Jan 11th

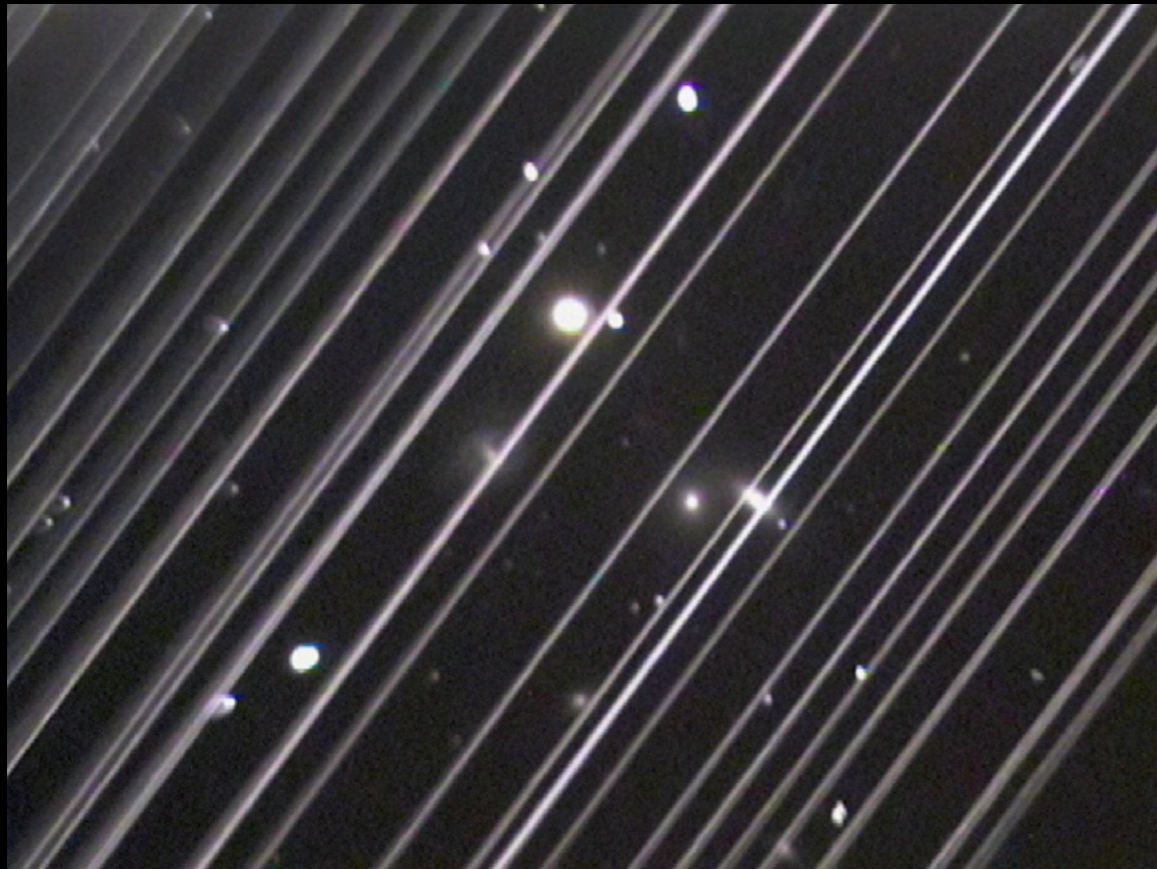
Space Debris



- Meteors [Gr. *ta meteōra*: “the celestial phenomena” or “things in heaven above”] → **Geminids, Ursids, Quadrantids**
- Asteroids [Gr. *asteroeides*: “star-like”] → **Eunomia, Vesta**
- Comets 🌠 [Gr. *komētēs*: “long-haired (star)”] → **C/2017 T2 (Panstarrs)**
- **ISS** Passes: evenings Dec 12-15, Jan 10-13; mornings Dec 17, Dec 19-21
- **Starlink** 😓: Pre Sunrise Dec 11-19, Post Sunset Dec 20-Jan 11
- **Pollution!!** Modelled impact of 50,000 satellites on LSST images (122 launched ytd; 60/launch planned)
 - **90%** have bright saturated trail within 2 hr of sunrise or sunset and 40% impacted during longer summer twilight (Chile)

www.heavens-above.com

Space Debris



This image of a distant galaxy group from Arizona's Lowell Observatory is marred by diagonal lines from the trails of Starlink satellites shortly after their launch in May.

Victoria Girgis/Lowell Observatory



[View at EarthSky Community Photos.](#) | EarthSky friend [Padraic Koen](#) was in Arkaroola, South Australia this morning, when a swarm of 25 SpaceX StarLink satellites passed over between 4:51 and 5:01 a.m. He created this composite of three 15-second shots – taken a few minutes apart – that captured 14 of the satellites. Thank you, Padraic!

www.heavens-above.com

Space Debris: Starlink



- Typical **Starlink** 🤔 pass
 - December 20th at 6:05 pm for 1.5 min
 - 54 satellites and 3 rocket stages
 - Magnitudes +5 to +6 (though some flared at launch)

| Date | Satellite | Brightness (mag) | Start | | | Highest point | | | End | | |
|-------------|---------------|---------------------|----------|----------|---------|---------------|----------|---------|----------|----------|---------|
| | | | Time | Altitude | Azimuth | Time | Altitude | Azimuth | Time | Altitude | Azimuth |
| 20 December | FALCON 9 DEB | 4.8 | 18:05:57 | 10° | SSE | 18:06:28 | 12° | SSE | 18:06:28 | 12° | SSE |
| 20 December | STARLINK 1038 | 5.7 | 18:17:28 | 10° | SE | 18:17:30 | 10° | SE | 18:17:30 | 10° | SE |
| 20 December | FALCON 9 DEB | NaN | 18:17:07 | 10° | S | 18:17:46 | 14° | SSE | 18:17:46 | 14° | SSE |
| 20 December | STARLINK 1046 | 5.6 | 18:27:29 | 10° | SSE | 18:28:08 | 12° | SSE | 18:28:08 | 12° | SSE |
| 20 December | STARLINK 1025 | 5.2 | 18:29:55 | 10° | S | 18:30:33 | 13° | SSE | 18:30:33 | 13° | SSE |
| 20 December | STARLINK 1050 | 5.5 | 18:30:09 | 10° | SSE | 18:31:00 | 13° | SSE | 18:31:00 | 13° | SSE |
| 20 December | STARLINK 1014 | 5.2 | 18:30:24 | 10° | S | 18:31:02 | 13° | SSE | 18:31:02 | 13° | SSE |
| 20 December | STARLINK 1007 | 5.2 | 18:31:25 | 10° | S | 18:32:04 | 13° | SSE | 18:32:04 | 13° | SSE |
| 20 December | STARLINK 1010 | 5.2 | 18:31:27 | 10° | S | 18:32:06 | 13° | SSE | 18:32:06 | 13° | SSE |
| 20 December | STARLINK 1055 | 5.5 | 18:32:05 | 10° | S | 18:32:56 | 13° | SSE | 18:32:56 | 13° | SSE |
| 20 December | STARLINK 1019 | 5.3 | 18:32:15 | 10° | S | 18:32:51 | 13° | SSE | 18:32:51 | 13° | SSE |
| 20 December | STARLINK 1021 | 5.2 | 18:32:15 | 10° | S | 18:32:54 | 13° | SSE | 18:32:54 | 13° | SSE |
| 20 December | STARLINK 1057 | 5.2 | 18:32:17 | 10° | S | 18:32:55 | 13° | SSE | 18:32:55 | 13° | SSE |
| 20 December | STARLINK 1028 | 5.2 | 18:32:18 | 10° | S | 18:32:57 | 13° | SSE | 18:32:57 | 13° | SSE |
| 20 December | STARLINK 1039 | 5.5 | 18:32:16 | 10° | SSE | 18:33:03 | 13° | SSE | 18:33:03 | 13° | SSE |
| 20 December | STARLINK 1051 | 5.2 | 18:32:48 | 10° | S | 18:33:26 | 13° | SSE | 18:33:26 | 13° | SSE |
| 20 December | STARLINK 1012 | 5.2 | 18:32:48 | 10° | S | 18:33:26 | 13° | SSE | 18:33:26 | 13° | SSE |
| 20 December | STARLINK 1027 | 5.2 | 18:33:03 | 10° | S | 18:33:41 | 13° | SSE | 18:33:41 | 13° | SSE |
| 20 December | STARLINK 1013 | 5.2 | 18:33:17 | 10° | S | 18:33:56 | 13° | SSE | 18:33:56 | 13° | SSE |
| 20 December | STARLINK 1022 | 5.5 | 18:33:33 | 10° | S | 18:34:25 | 14° | SSE | 18:34:25 | 14° | SSE |
| 20 December | STARLINK 1016 | 5.3 | 18:34:07 | 10° | S | 18:34:45 | 13° | S | 18:34:45 | 13° | S |
| 20 December | STARLINK 1009 | 5.3 | 18:35:24 | 10° | S | 18:36:03 | 13° | S | 18:36:03 | 13° | S |
| 20 December | STARLINK 1056 | 5.5 | 18:35:49 | 10° | S | 18:36:41 | 14° | SSE | 18:36:41 | 14° | SSE |
| 20 December | STARLINK 1015 | 5.3 | 18:36:05 | 10° | S | 18:36:43 | 13° | S | 18:36:43 | 13° | S |
| 20 December | STARLINK 1042 | 5.5 | 18:36:14 | 10° | S | 18:37:08 | 14° | SSE | 18:37:08 | 14° | SSE |
| 20 December | STARLINK 1026 | 5.3 | 18:36:31 | 10° | S | 18:37:10 | 14° | S | 18:37:10 | 14° | S |
| 20 December | STARLINK 1011 | 5.3 | 18:36:41 | 10° | S | 18:37:15 | 13° | S | 18:37:15 | 13° | S |
| 20 December | STARLINK 1045 | 5.5 | 18:37:02 | 10° | S | 18:37:54 | 14° | SSE | 18:37:54 | 14° | SSE |

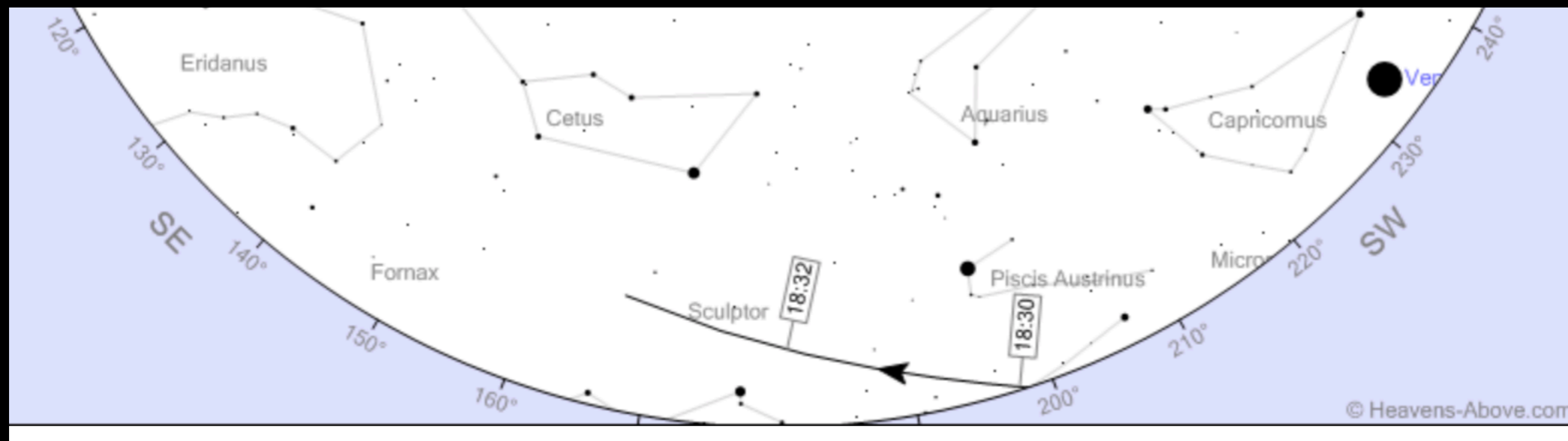
W O W!
Partial List

www.heavens-above.com

Space Debris: Starlink



One of the Satellites



www.heavens-above.com

Space Debris: Satellite Cocoon



- **Current Count:** 8,900 (only 1,900 operational with the other \cong 80% as space “debris”)
- **Potential Near Future Count is 59,000 counting all the following internet satellites!**
 - **SpaceX Starlink** (launched 120; 12,000 approved; potentially up to 42,000 total)
 - Amazon (3,236)
 - Boeing (2,956)
 - OneWeb (based in UK; main owner is Japan’s Softbank) (650)
 - Canada (298 Telesat)
 - Russia (288)
 - China (320+156 Hongyan)
 - UK’s Sky & Space Global (200)
 - Plus others

Space Debris: SpaceX Solution



- Coming to you Summer 2020 😊
 - 1 Gbps low latency broadband with hopefully inexpensive Earthbound terminals/antennas @ \$xx Monthly fee
- Coverage
 - Minor coverage after 6-8 launches and ≈ 400 Starlink sat's; moderate coverage with ≈ 800 Starlink sat's
 - For global coverage, 24 more launches
 - Low Earth orbits of 550 km until de-orbited in 1-5 years
- SpaceX working with astronomy groups including the American Astronomical Society (AAS) and National Radio Astronomy Observatory (NRAO)
 - Since especially impacts NEO search and Dark Energy Surveys
 - Coordinate launch schedules with astronomical observations
 - Testing painting the bottoms "black"
- Projected payback with 1,000 satellites over 5 years on \$10 B investment with land and space based competition??

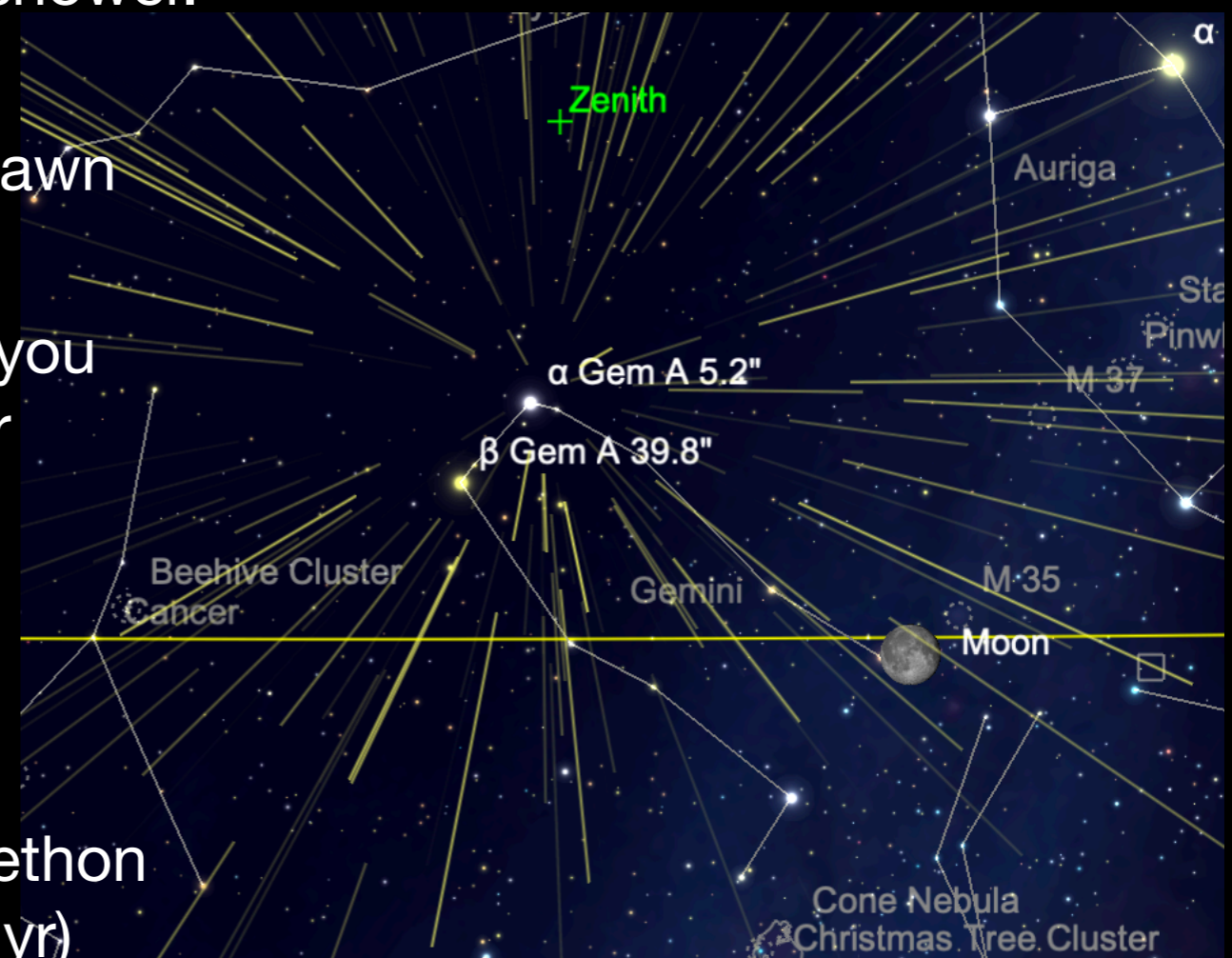
Space Debris: Meteor Showers



- **Geminids** peak Dec 13th - 14th, but observable Dec 4th-17th
 - Reliable and usually spectacular shower. Lots of fireballs
 - View from 9 pm but best before dawn (2 am) when Gemini high
 - Nearly full moon will cut meteors you might see from 100/hr to 20-30/hr

- *Background*

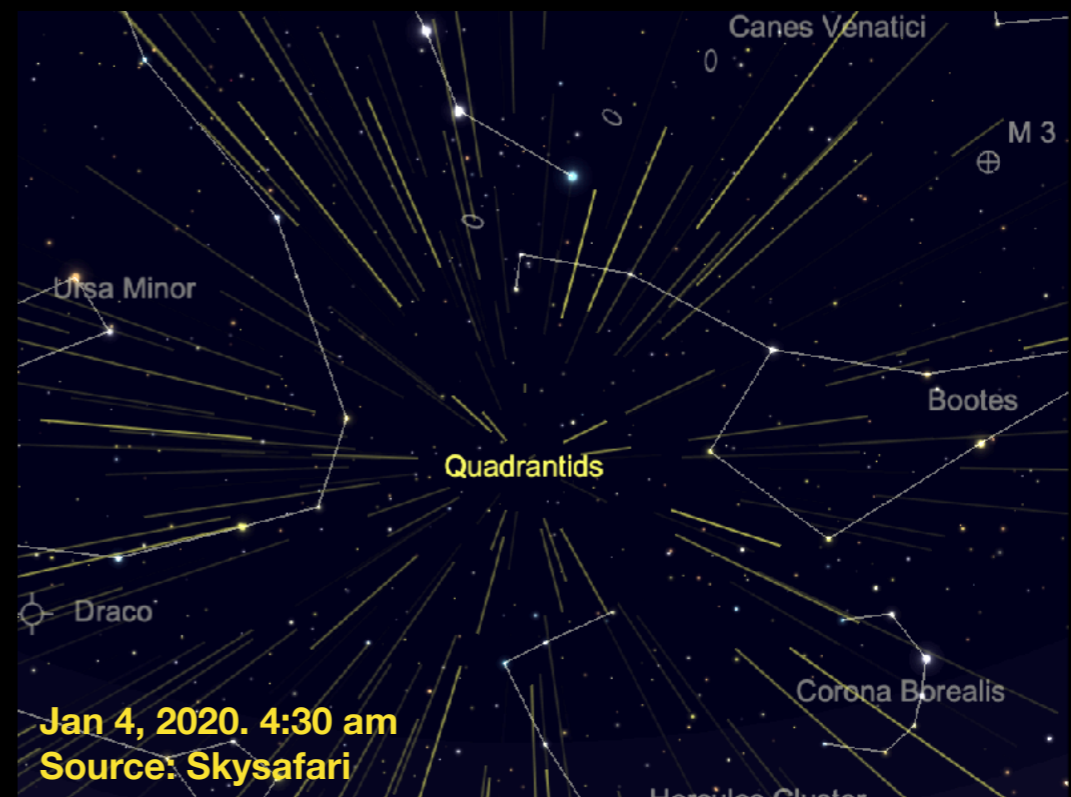
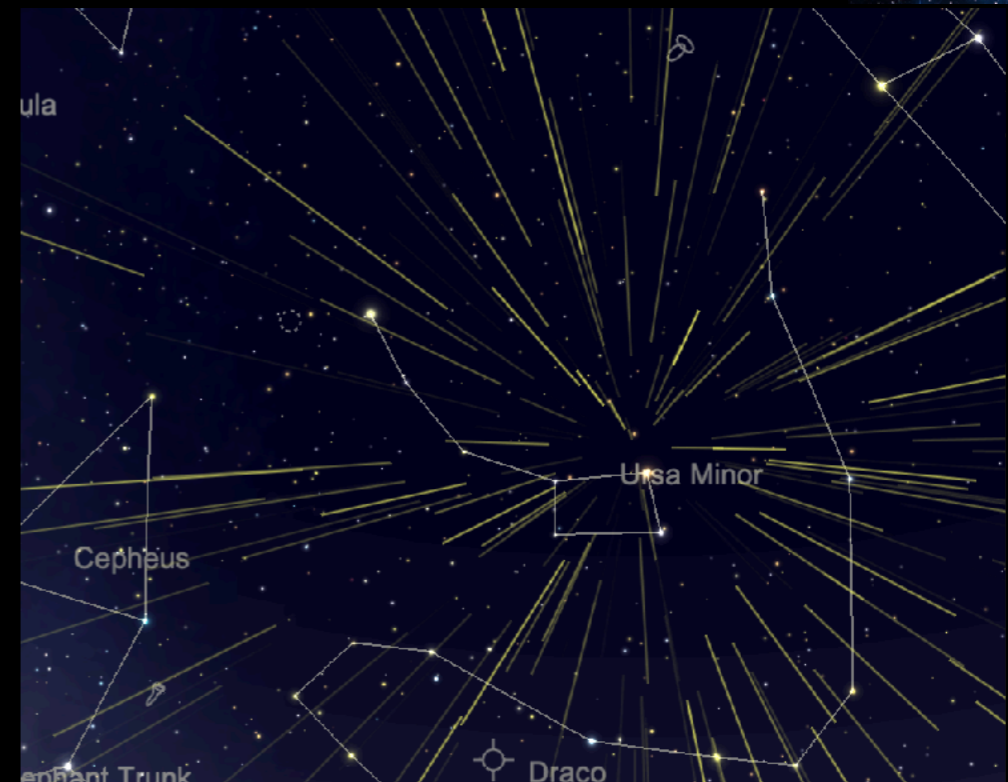
- First observed mid-1800's
- Source: Asteroid 3200 Phaethon (discovered 1983; orbit 1.4 yr)
- Due to Jupiter's tug, shower is **getting brighter!**



Space Debris: Meteor Showers



- **Ursids** are best observed on night of Dec 22nd though shower spans Dec 17th-26th. (Moon waning crescent @14%)
 - Weak shower of 5-10 meteors/hr but may surge to 30 meteors/hr (as in 2011 & 2014)
 - Located in Ursa Minor
 - Source is Comet 8P/Tuttle
- **Quadrantids** look great. Peak Jan 4th with rate that can match Perseids or Geminids, *but only for an 8 hr. period*
 - Best observed in morning post moonset on 4th, 15-25/hr
 - Located in Bootes near Ursa Major
 - Source is comet C/1490 Y1

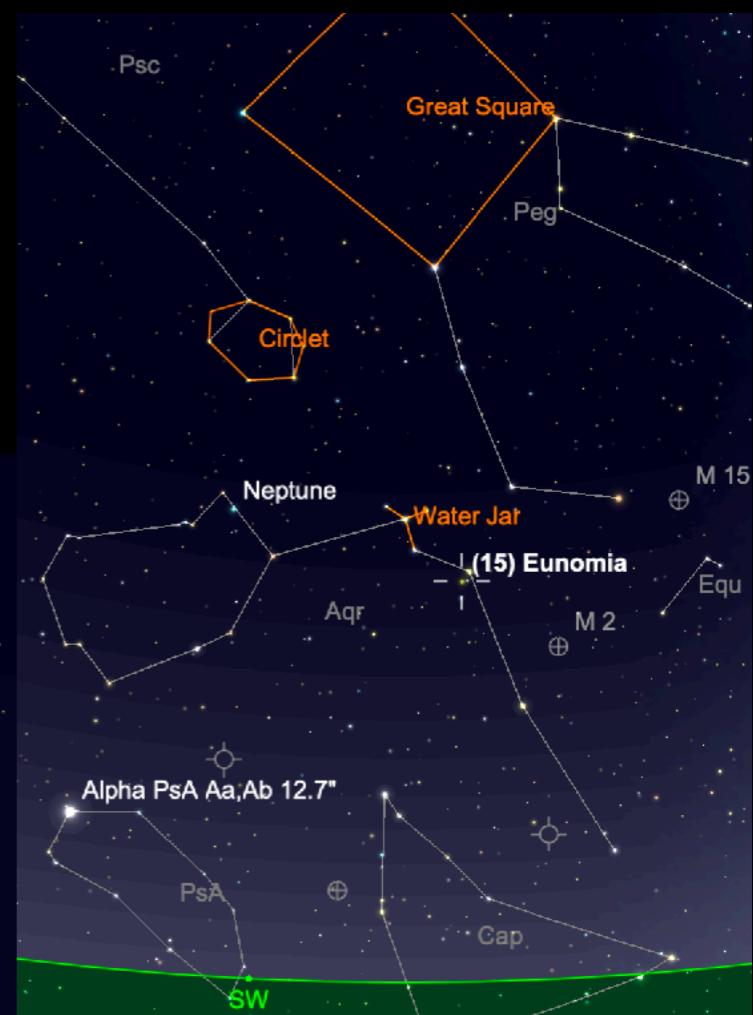
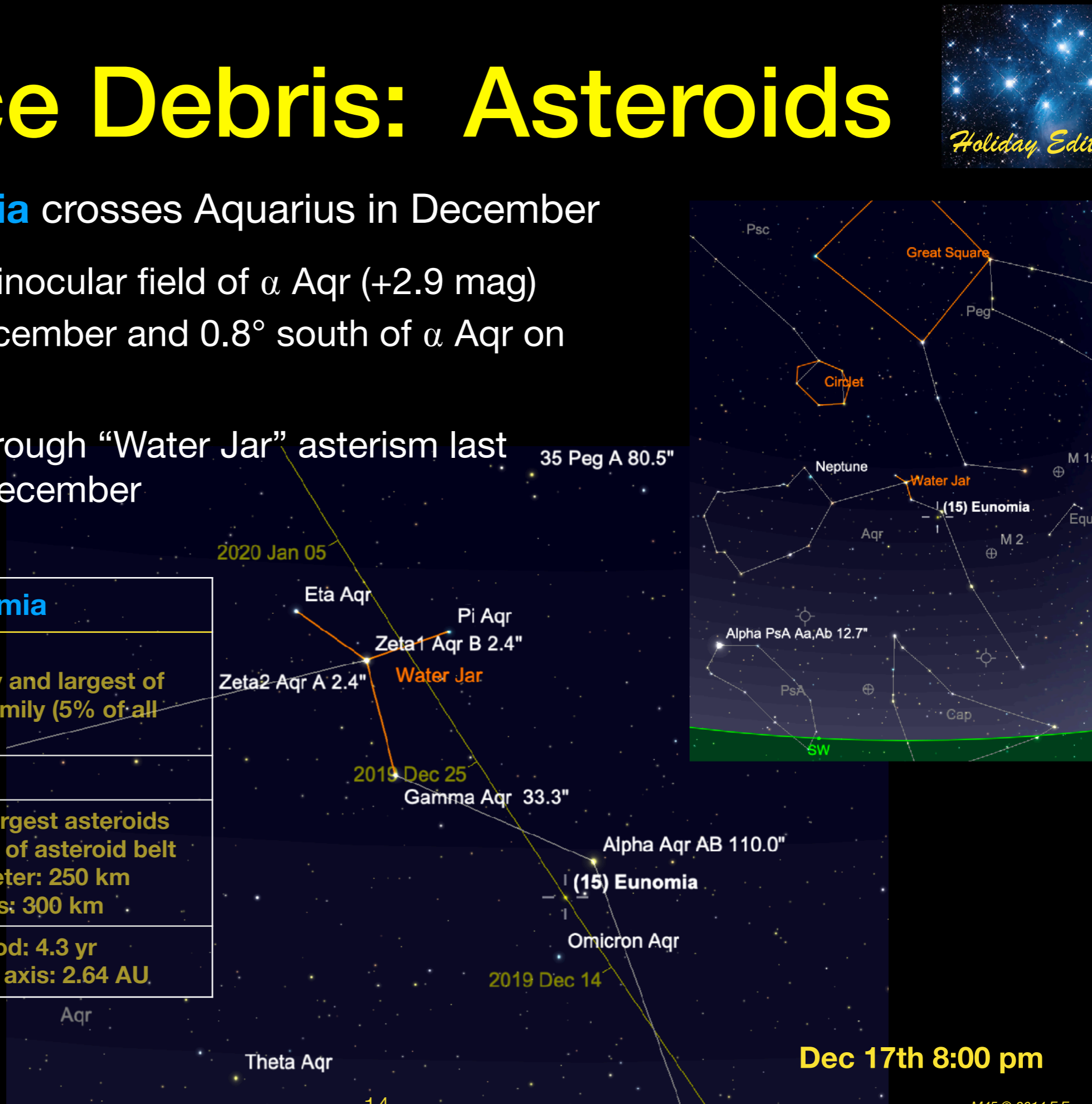


Space Debris: Asteroids



- **(15) Eunomia** crosses Aquarius in December
 - Within a binocular field of α Aqr (+2.9 mag) during December and 0.8° south of α Aqr on Dec 17th
 - Passes through “Water Jar” asterism last week of December

| (15) Eunomia | |
|---------------------|---|
| Discovery | <ul style="list-style-type: none"> • 1851 • Parent body and largest of Eunomia Family (5% of all asteroids) |
| Magnitude | • +10.0 |
| Size | <ul style="list-style-type: none"> • One of 12 largest asteroids • 1% of mass of asteroid belt • Mean diameter: 250 km • Longest axis: 300 km |
| Orbit | <ul style="list-style-type: none"> • Orbital Period: 4.3 yr • Semi-major axis: 2.64 AU |



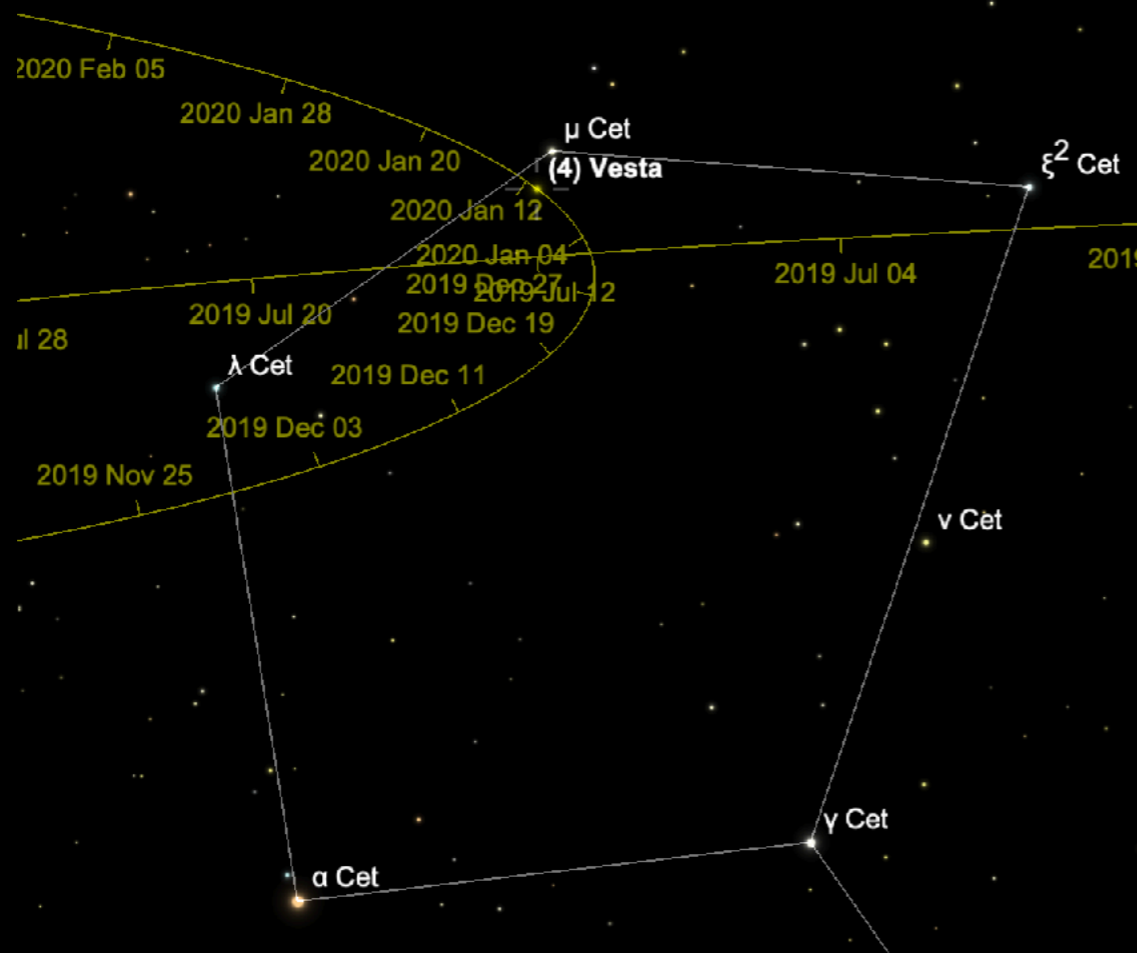
Dec 17th 8:00 pm

Space Debris: Asteroids



- **(4) Vesta** rides high, crossing Cetus, in January on way to Taurus in April
- Within a binocular field of μ Cet on Jan 11th (<22')

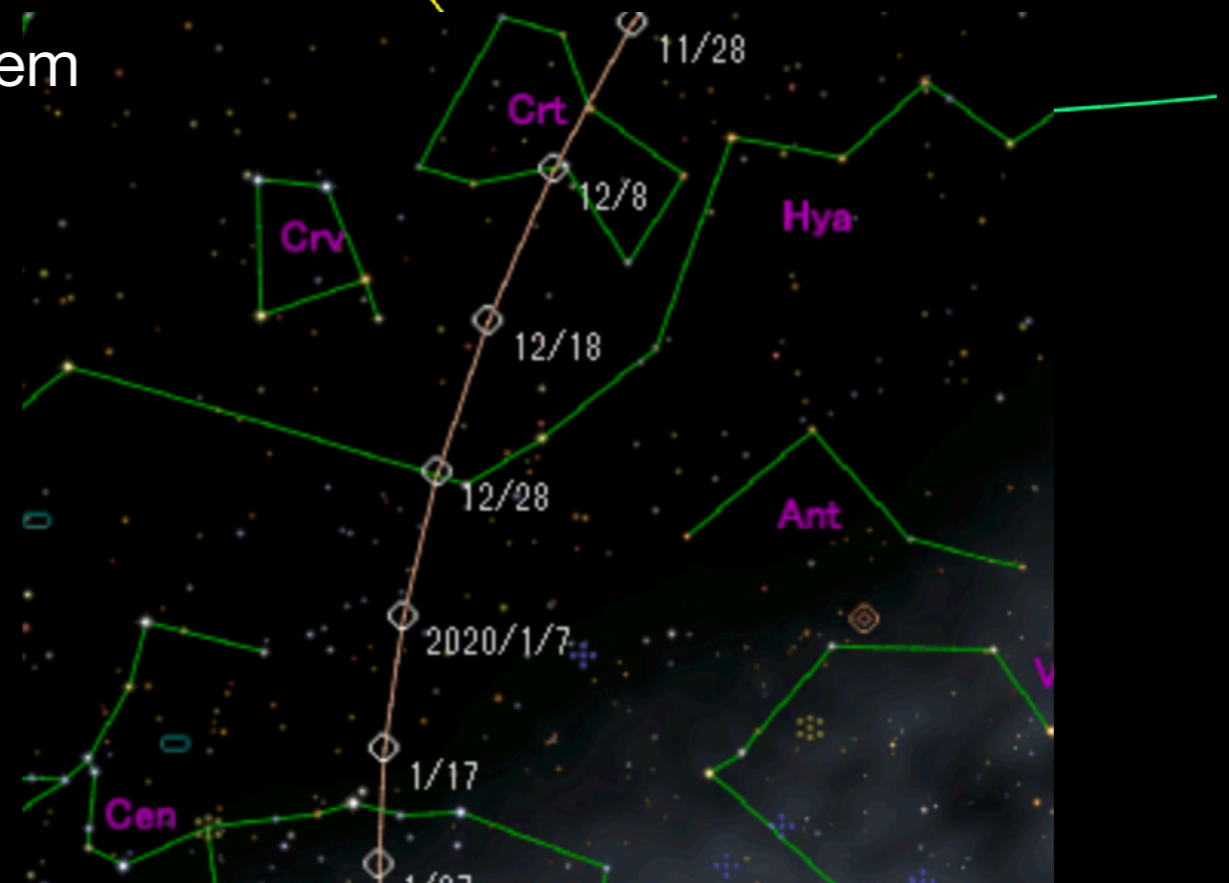
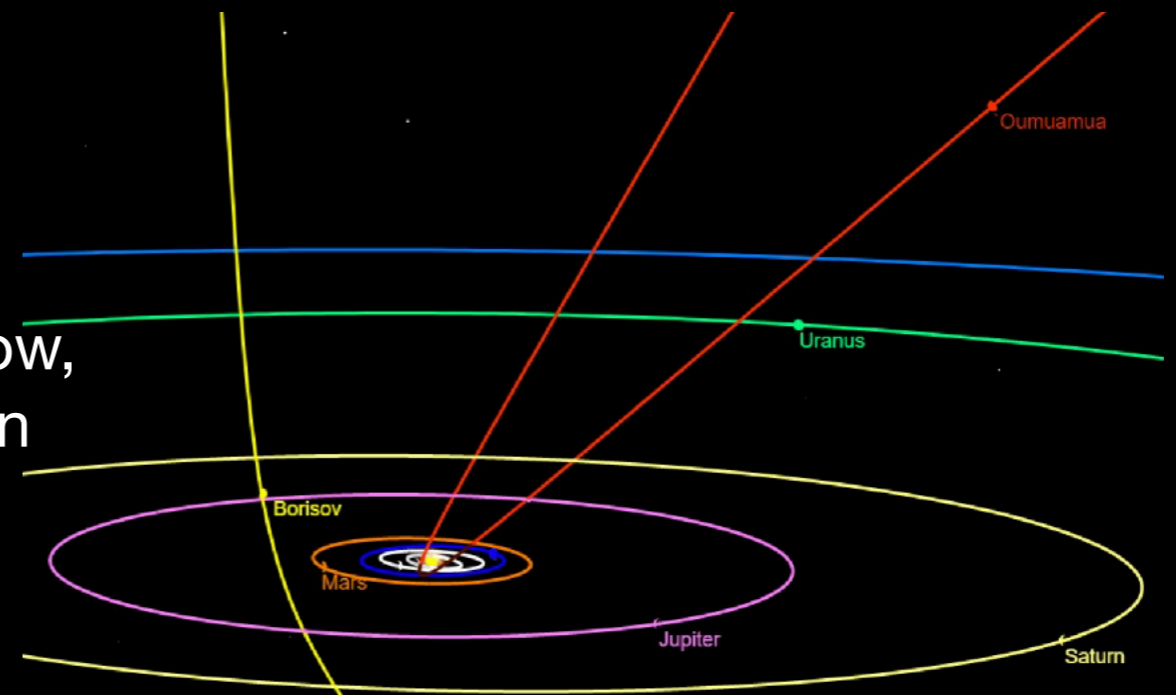
| (4) Vesta | |
|------------------|---|
| Discovery | <ul style="list-style-type: none"> • 1807, 4th discovered • Created < 1B yr ago • 5% of meteorites found are from Vesta due to this impact |
| Magnitude | • +7.6, Brightest asteroid |
| Size | <ul style="list-style-type: none"> • 2nd largest asteroid • 10% of mass of asteroid belt • Mean diameter: 525 km |
| Orbit | <ul style="list-style-type: none"> • Orbital Period: 3.6 yr • Semi-major axis: 2.4 AU |



Space Debris: Comets



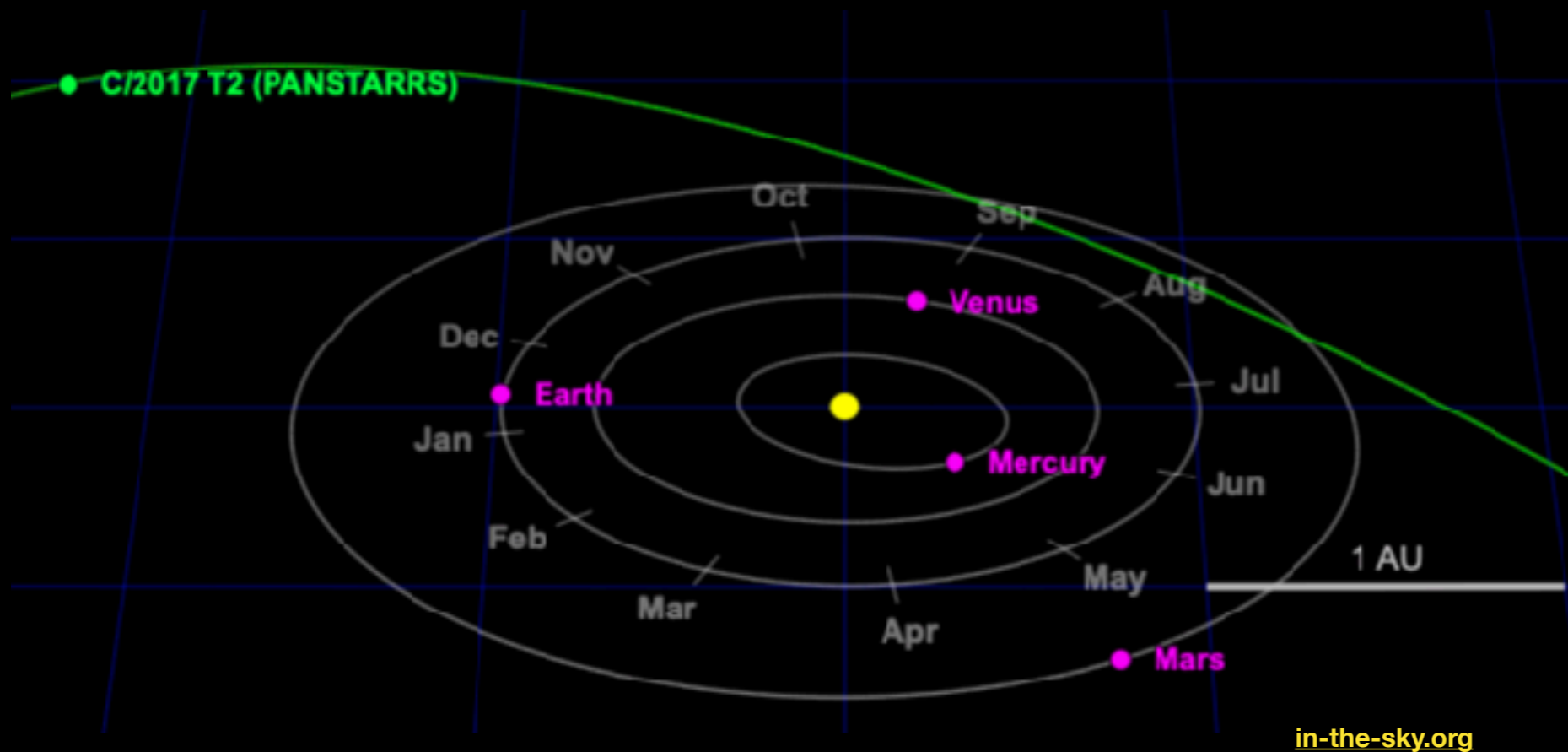
- **2I/Borisov** (“I” for interstellar) is our second visitor and first comet from interstellar space
- Though at closest approach to Sun now, its very faint (15th mag) and very low (in Crater). Sports a huge tail of about 160,000 km (12 Earths)
- Travelling at a breakneck speed of 150,000 km/hr out of our Solar System



Space Debris: Comets



- Catch a visitor from Oort Cloud, **C/2017 T2 (Panstarrs)**, on a “heroic” pass through Perseus. Overhead each evening this month
- Brightest comet of 2020?
 - 10th mag target ... brightening to 9th mag by mid-January
 - Predicted 8th mag by May 4th at closest to Sun of 1.6 AU

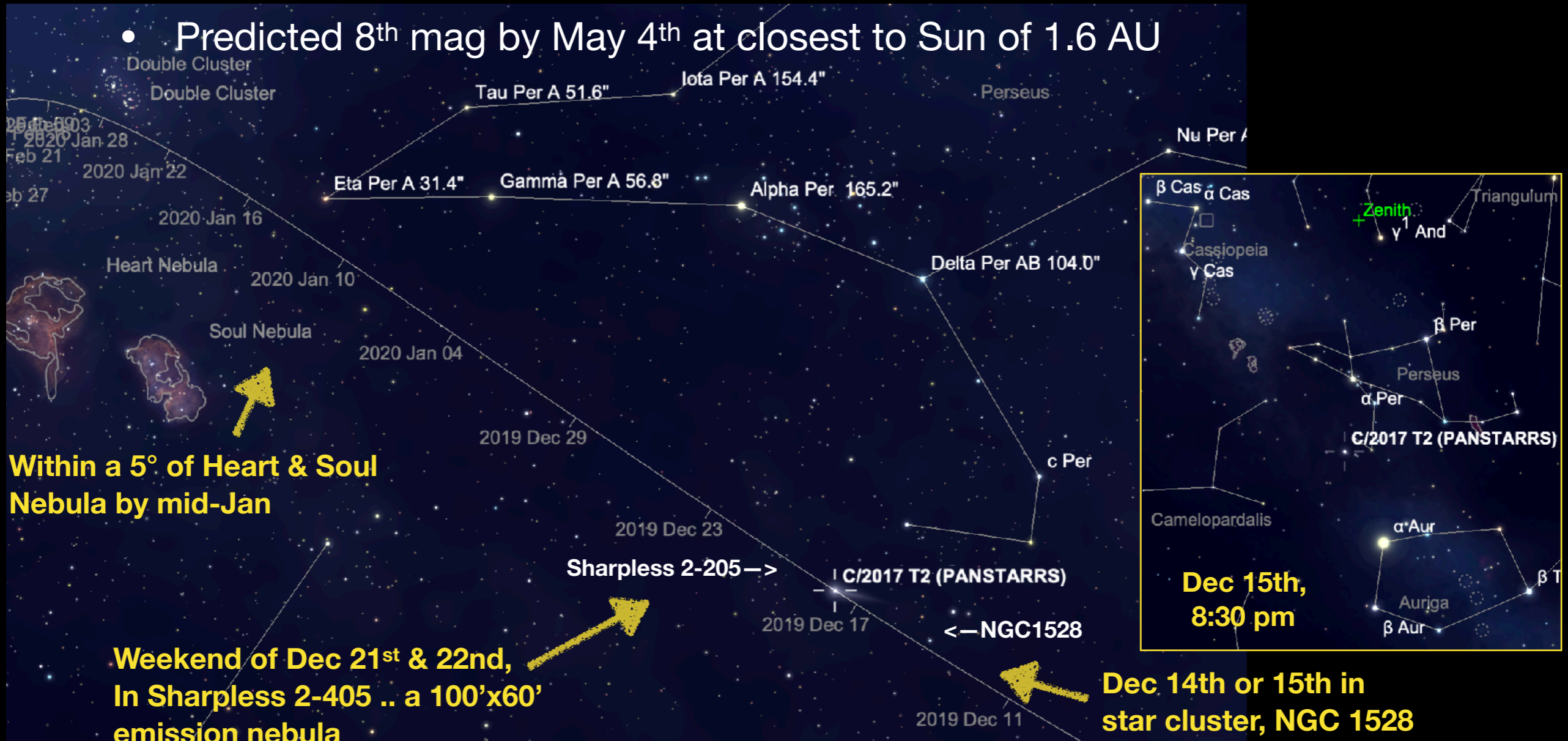


Space Debris: Comets



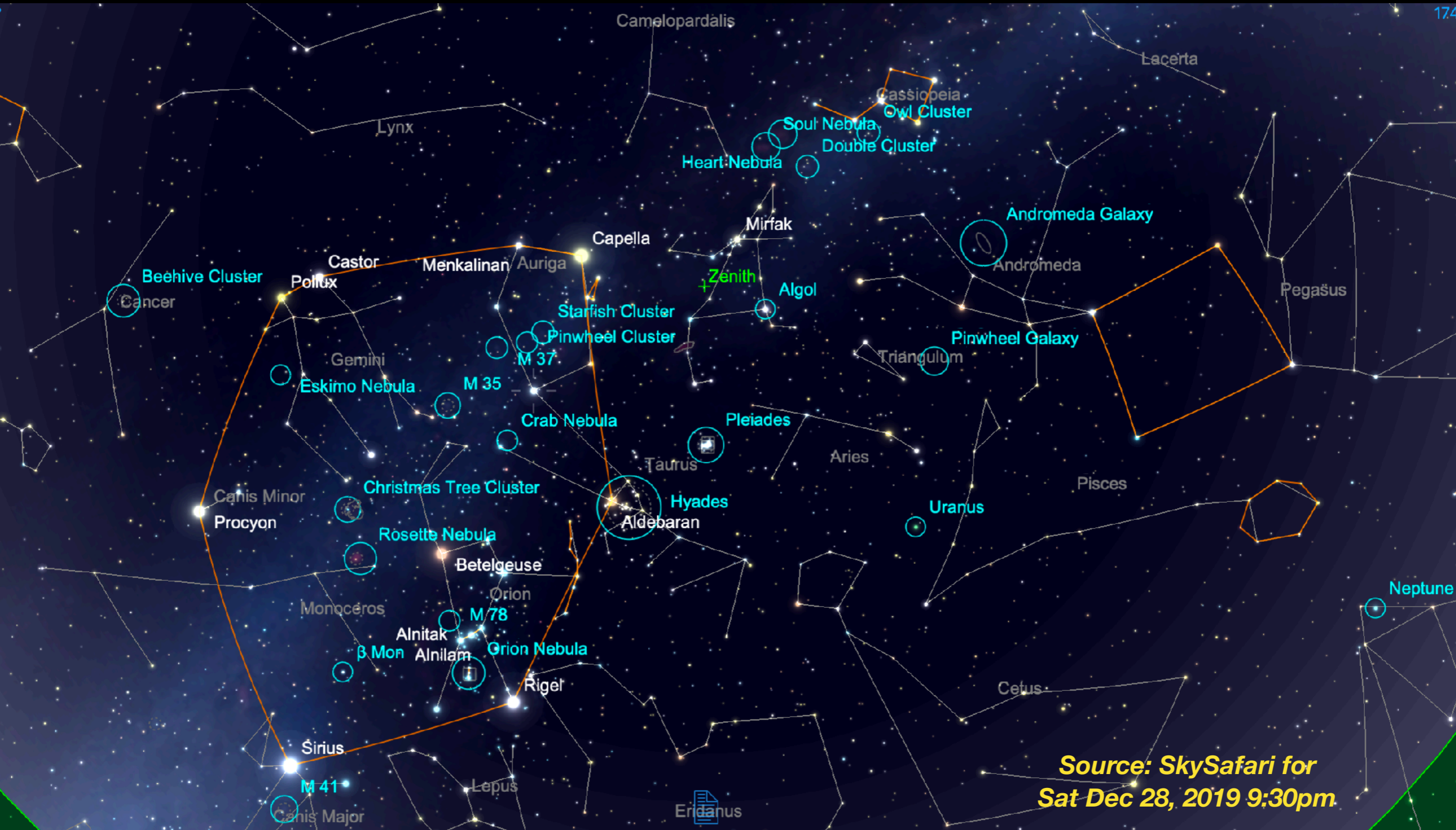
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Star Struck

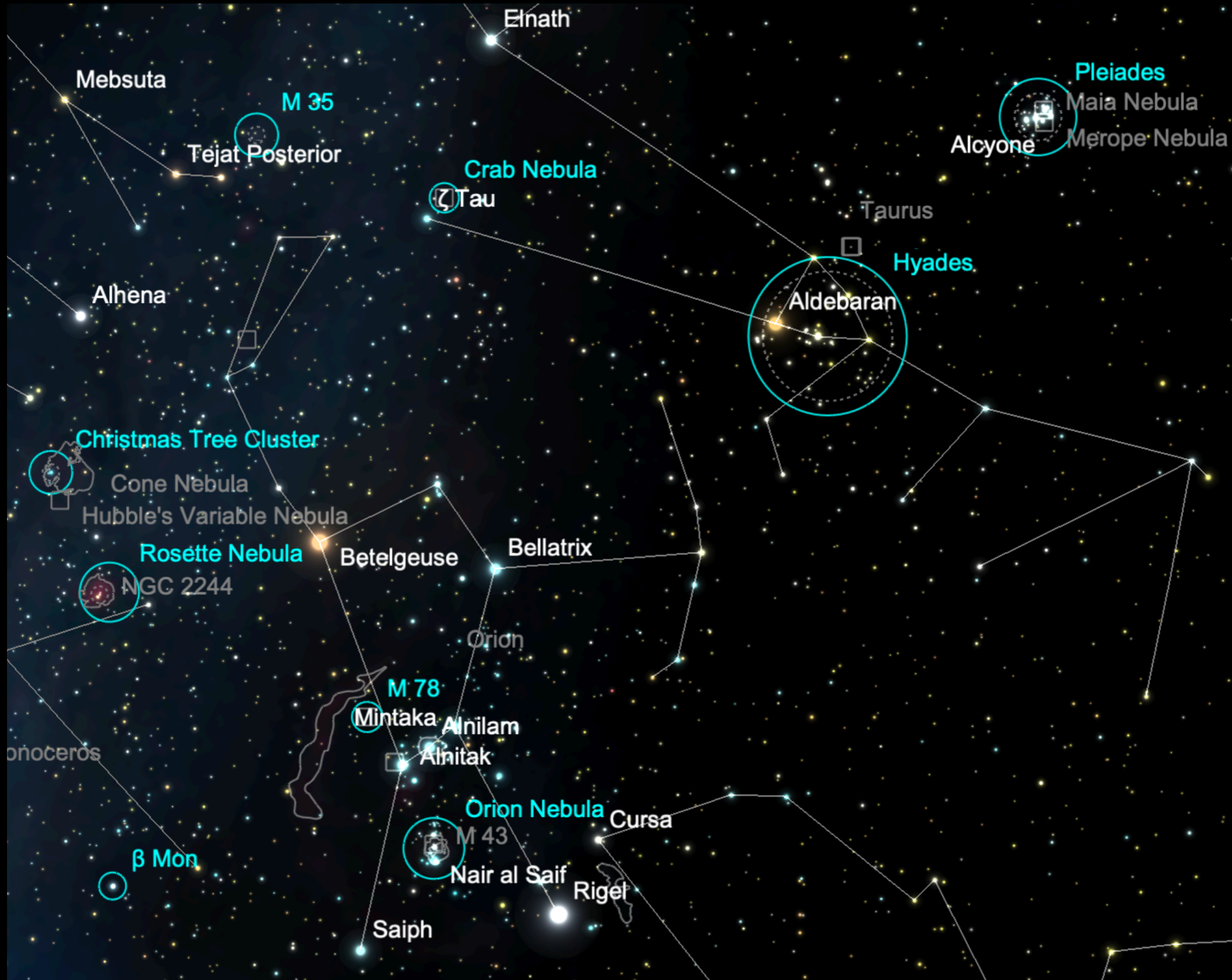
Holiday Edition



**Source: SkySafari for
Sat Dec 28, 2019 9:30pm**

Star Struck

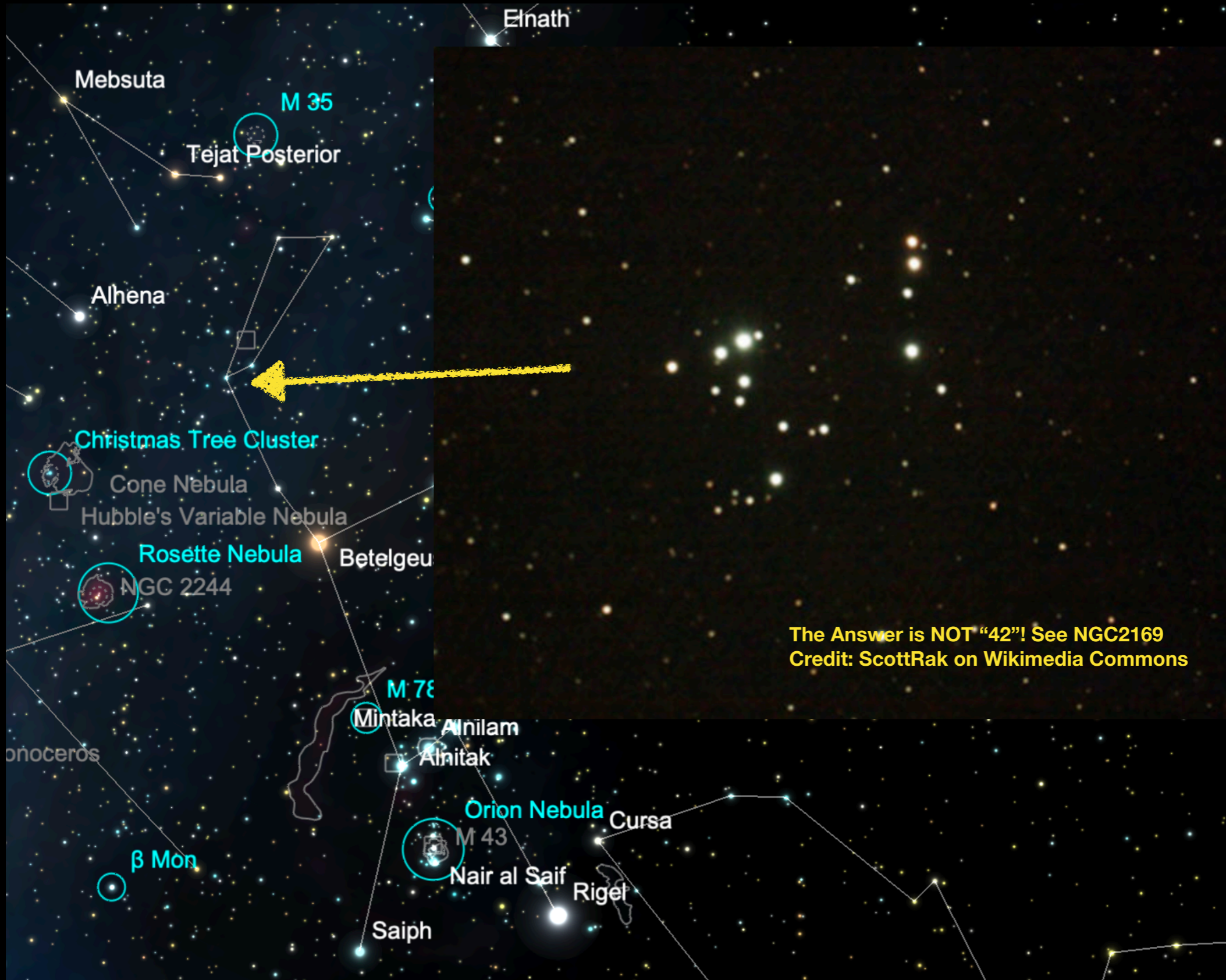
Holiday Edition



**Orion for
9:30pm**

Star Struck

Holiday Edition



**Orion for
9:30pm**

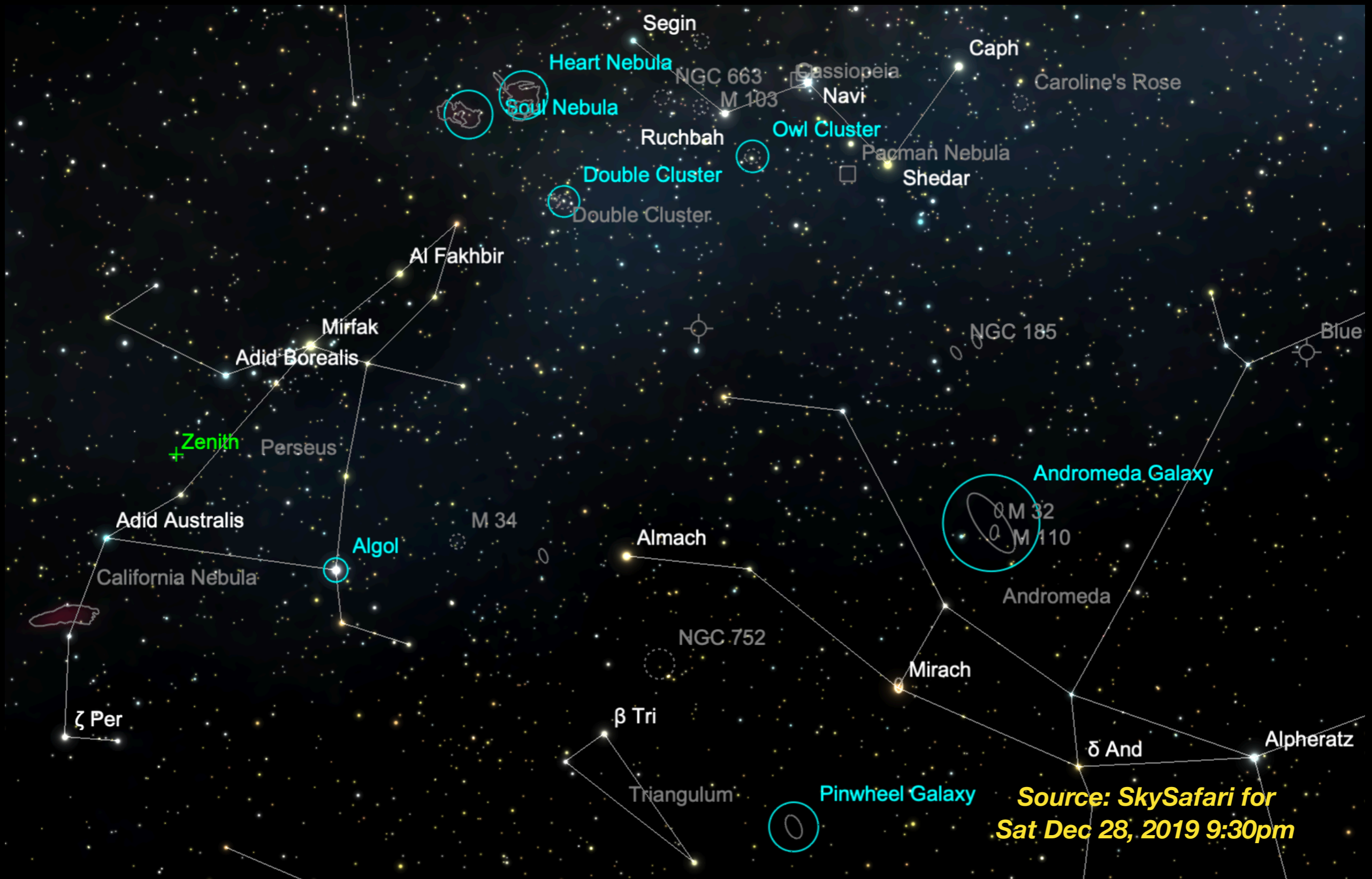
Star Struck



Source: SkySafari for Sat Dec 28, 2019 9:30pm

Star Struck

Holiday Edition



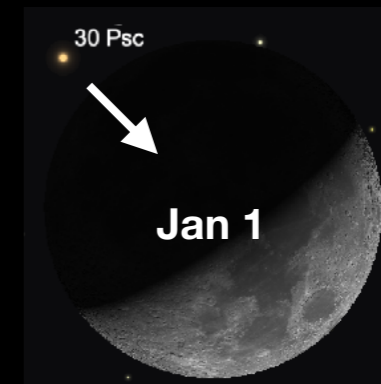
Source: SkySafari for Sat Dec 28, 2019 9:30pm

Occultations



- Lunar Occultations

| Date | Star | Moon |
|--|--|---|
| Dec 30 th , 7:57 pm | 56 Aqr (6.3 mag) | 21% Waxing SW @12° |
| Dec 31 st , 6:43 pm to 8:02 pm | HR8836, SAO165578, HIP114750 (6.11 mag, 3.6") | 29° Waxing SW @30° (HR8836 reappears @ 19°) |
| Jan 1 st , 8:31 pm to 9:40 pm | 30 Psc (4.4 mag) | 39% Waxing @26° (30 Psc reappears @ 14° alt) |
| No grazing lunar occultations | | |



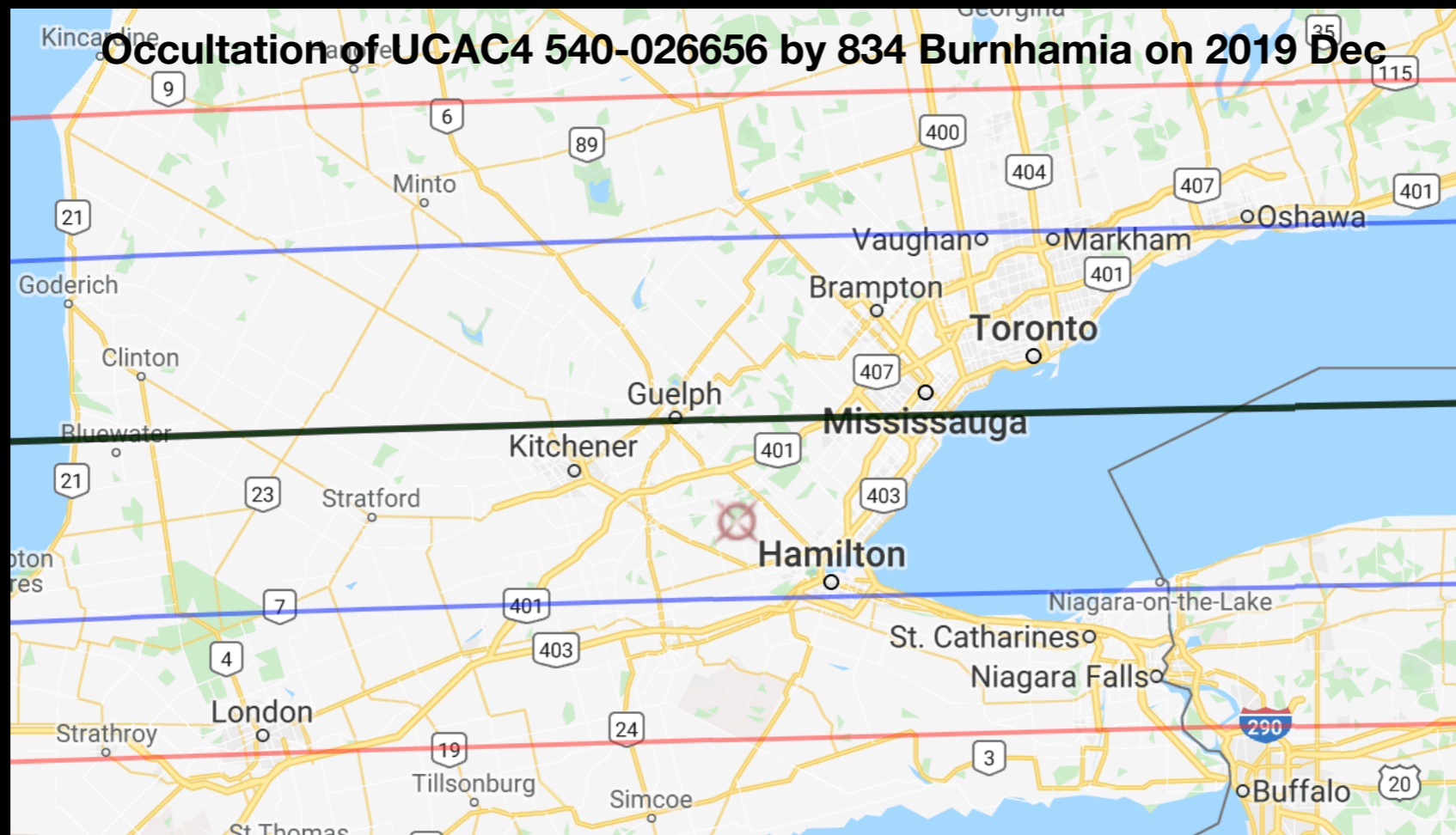
- Planetary (Asteroid) Occultations?



Occultations



- Faint star occulted just before the holidays with a 92% probability? Probably not?
- Dec 20th at 8:14 pm, 63.5 km diameter asteroid “**(834) Burnhamia**” occults 13.5 mag star UCAC4 540-026656 in Gemini. Magnitude drop of 1.7 mag to 15.0 mag for at most 3.9 sec. [ref. http://asteroidoccultations.com/2019_12/1220_834_67992.htm]



Source: <http://www.asteroidoccultation.com> (Steve Preston)

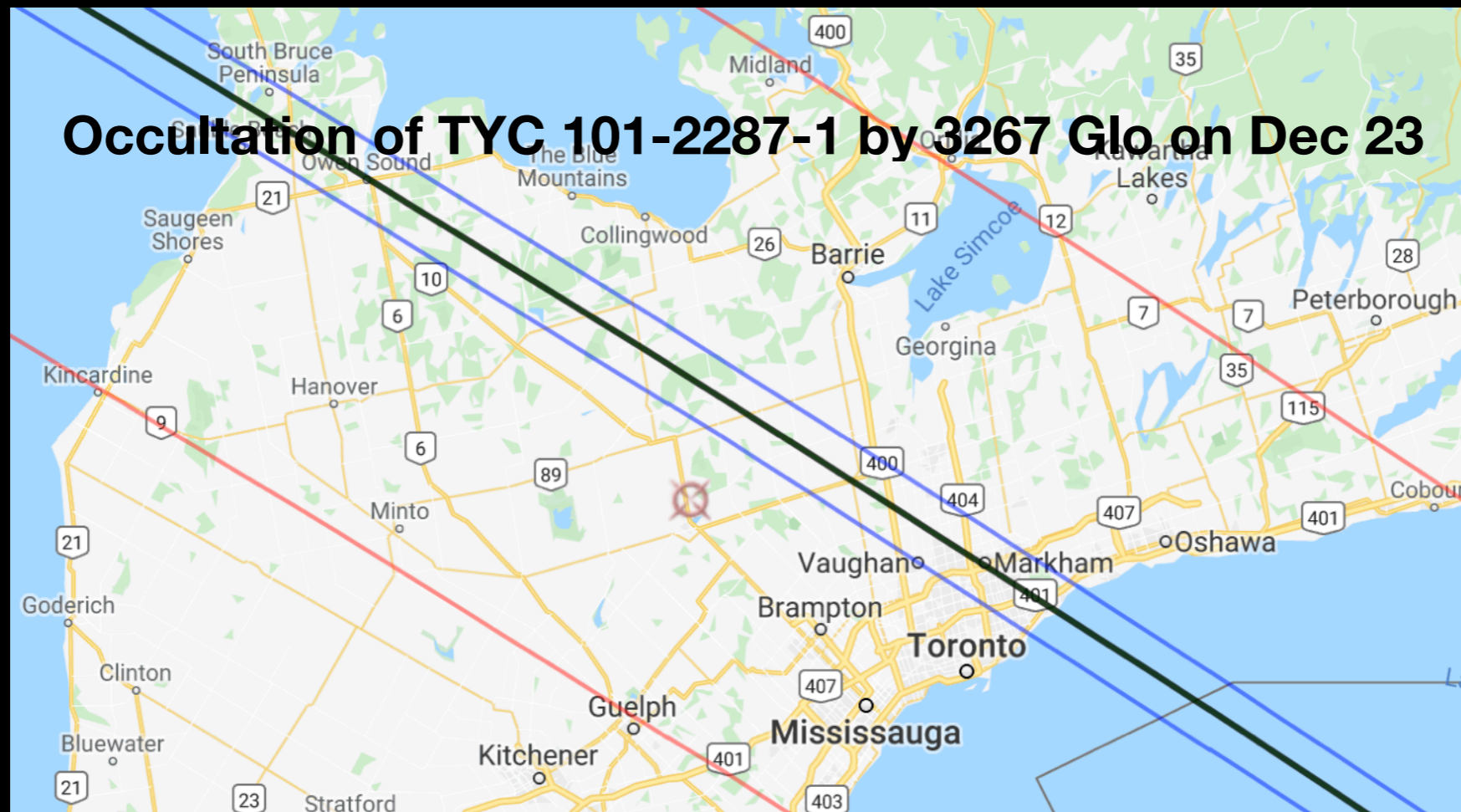
<http://www.randomadventures.com/asteroidoccultations.html> (for Google map)

RASC Handbook & website: <https://rascto.ca/content/asteroidal-occultations>

Occultations




- Bright-ish star occulted just before the holidays with a 23% probability? Probably not?
- Dec 23 at 8:02 pm, 13.5 km diameter asteroid **(3267) GLO** occults 9.5 mag TYC 101-2287-1 (HD 290414) in Orion. Magnitude drop of 4.6 to 14.1 for at most 1.1 sec. [ref. http://www.asteroidoccultation.com/2019_12/1224_3267_67576.htm]

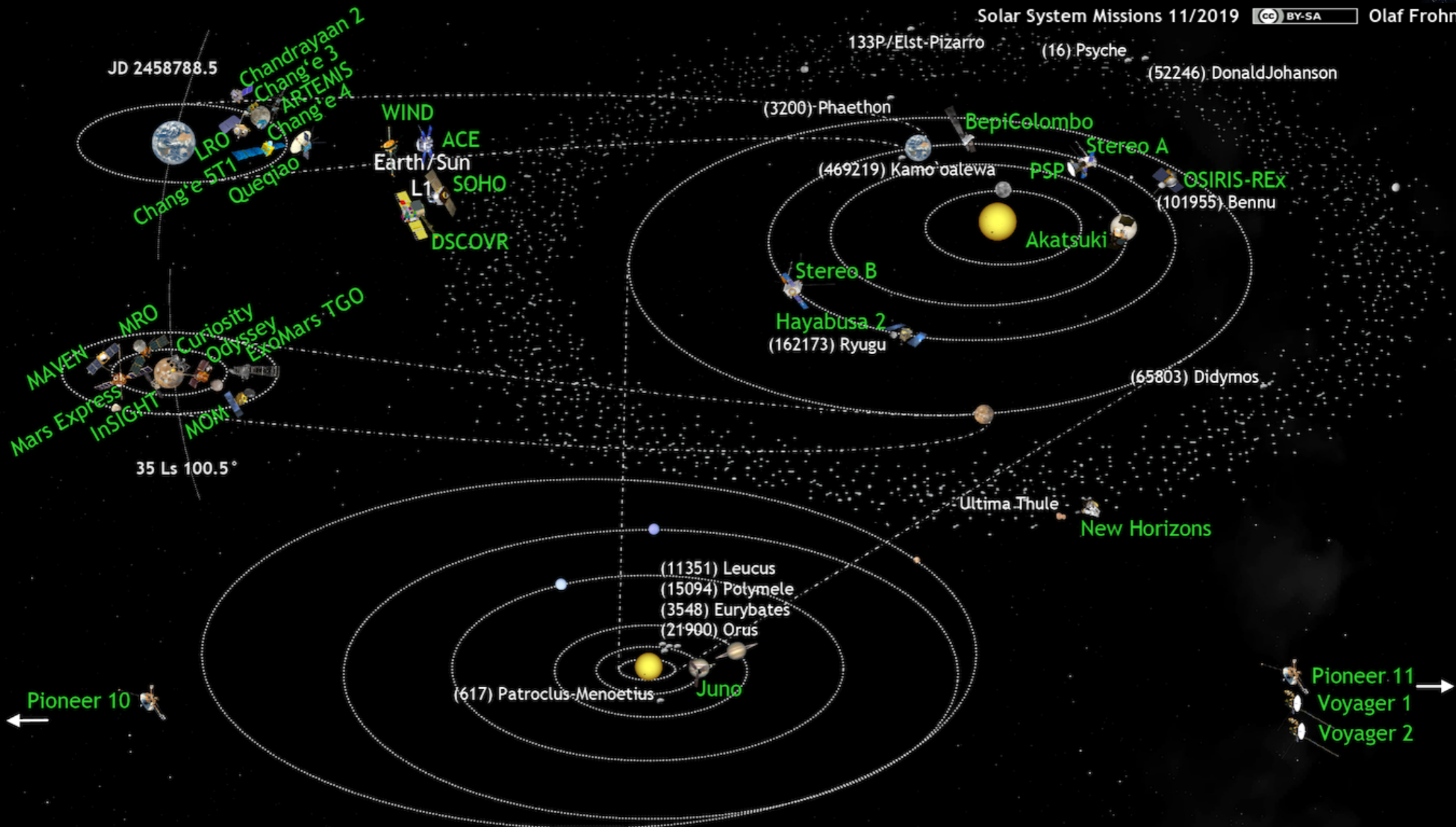


Source: <http://www.asteroidoccultation.com> (Steve Preston)
<http://www.randomadventures.com/asteroidoccultations.html> (for Google map)
RASC Handbook & website: <https://rascto.ca/content/asteroidal-occultations>

Space Missions

Holiday Edition

Solar System Missions 11/2019  Olaf Frohn



Upcoming Events

2019

Nov/Dec: Hayabusa 2 Dep Ryugu
Dec: OSIRIS-REx SR Test Benu
Dec: Parker Solar Probe Flyby Venus

2020

Feb: Solar Orbiter Launch
Apr: BepiColombo Flyby Earth
Jul: OSIRIS-REx SR Benu
Jul: Parker Solar Probe Flyby Venus
Jul: 2020 Mars Rover Launch

SR: Sample Retrieval; OI: Orbit Insertion; App: Approach; Dep: Departure
EDL: Entry, Descent and Landing; TD: Touchdown; EOM: End of Mission

Jul: ExoMars 2020 Launch

Jul: Mars Hope Launch
Jul: Huoxing-1 Launch to Mars
Oct: BepiColombo Flyby Venus
Nov: Hayabusa 2 EDL Earth
Dec: Chang'e 5 Launch/SR Moon

2021

Feb: Parker Solar Probe Flyby Venus
Mar: OSIRIS-REx Dep Benu
Jul: CLPS Peregrin Launch/TD Moon
Jul: CLPS NOVA-C Launch/TD Moon

Jul: DART Launch to Didymos

Aug: BepiColombo Flyby Venus
Oct: Parker Solar Probe Flyby Venus
Oct: BepiColombo Flyby Mercury
Aditya L1 Launch to Earth/Sun L1
Artemis-1 Launch/Flyby Moon
+13 EM-1 Cubesats Launch/OI/Flyby Moon/Heliocentric Orbit
ExoMars Rover EDL Mars
Juno EOM
Lucy Launch to Jupiter-Trojans
Luna 25 Lander Launch
SLIM Launch/TD Moon

2022

DART App/Impact (65803) Didymos
DESTINY+ Launch to (3200) Phaeton
Europa Clipper Launch to Jupiter
Gateway PPE Launch to NRHO
JUICE Launch to Jupiter
KPLO Launch/OI Moon
MOM-2 Launch to Mars
Psyche Launch to (16) Psyche
VIPER Launch/TD Moon
Zheng He Launch/SR Kamo'oalewa
2023+
Chang'e 7 Launch/TD Moon

Artemis-2 Launch to Lunar Flyby

Gateway HALO Launch to NRHO
OSIRIS-REx EDL Earth
Chang'e 6 Launch/SR Moon (2024)
Luna 26 Orbiter Launch (2024)
MMX Launch to Mars (2024)
Federatsia Launch to Moon (2024)
Artemis-3 TD Moon (2024)
Bepi-Colombo OI Mercury (2025)
Luna 27 Lander Launch (2025)
NEOSM Launch to Earth/Sun L1 (2025)
Dragonfly Launch to Titan (2026)
Chang'e 8 Launch/SL Moon (2027)

Space Launches



- **NET Dec 15/16 JCSAT 18/Kacific 1:** a SpaceX Falcon 9 rocket will launch a satellite built by Boeing for Japan and Singapore to provide mobile and broadband services across the Asia-Pacific region
- **Dec 16/17 CBERS 4A:** Chinese launch of 5th China-Brazil Earth Resources Satellite for the collection of global imagery for environmental, urban planning and agricultural apps
- ✓ **NET Dec 17 COSMO-SkyMed Second Generation (CSG 1) & Characterizing Exoplanet Satellite (CHEOPS):** From Guiana, a Soyuz will carry the first CSG 1, radar surveillance satellite for Italy. A secondary payload is the ESA's CHEOPS which will observe transits of planets around other stars to measure their radii
- ✓ **NET Dec 19 Boeing's Starliner CST-100:** 1st test flight (uncrewed) of the new commercial spacecraft ("taxi") to dock with the ISS and then return to the western USA. Starliner is designed to fly on an Atlas-V N22 booster to carry astronauts to the ISS
- ✓ **Dec 19 ONEWEB-2:** Russian Soyuz-2.1b to launch OneWeb-2 satellites from Kazakhstan. Like SpaceX, OneWeb will field a constellation of satellites meant to provide low-latency broadband internet services. OneWeb-3 will launch ≈ 32 more satellites in early 2020
- **Dec 24 ELECTRO-L 3:** Russian geostationary weather satellite
- **Dec 25 Gonets M:** three Russian communications satellites

Space Launches

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- Competitors



Compare Your Ride

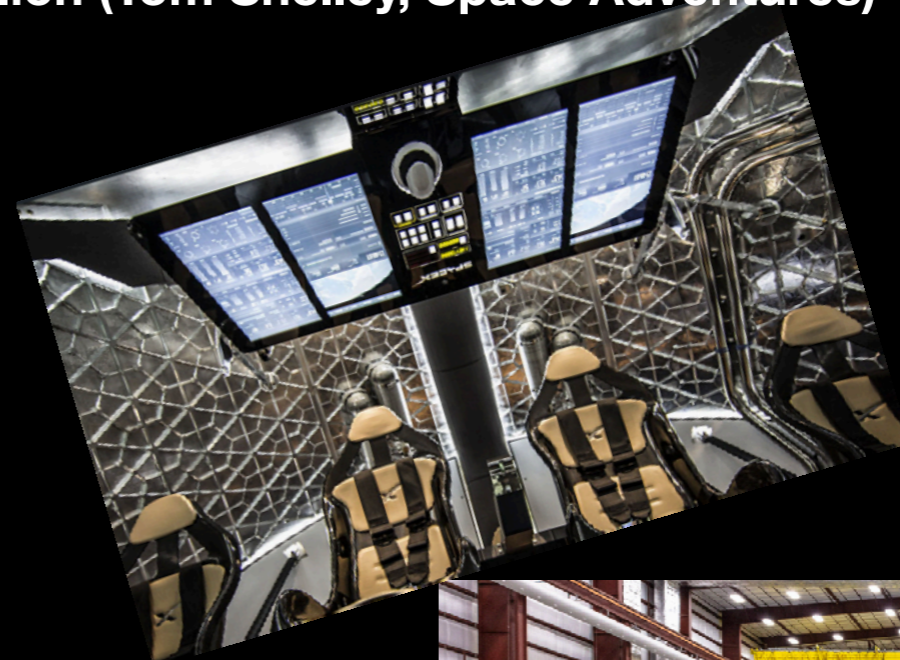
Holiday Edition ©



- NASA's contract with Russia to use Soyuz expires end of 2019
- NASA was counting on SpaceX's Dragon and Boeing's Spaceliner to be ready before end of 2019
- Each accommodates up to 7 passengers, or a mix of crew and cargo, for missions to low-Earth orbit
- Tourist trips may cost \$52 million (Tom Shelley, Space Adventures)



STARLINER



YOUR RIDE IS HERE.

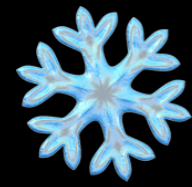


Space Launches



- ✓ **TBD LauncherOne**: Virgin Orbit LauncherOne rocket to make its first orbital test flight dropped from a modified Boeing 747 (*Cosmic Girl*)
- **Dec TBD RISAT 2BR1 + others**: India will launch a radar Earth observation satellite. Piggybacking are the Japanese QPS-SAR microsatellite and four Lemur 2 CubeSats for Spire Global
- **Dec TBD Shijian 20**: newer, heavier, higher-power next-gen design Chinese communications satellite
- **Dec TBD Beidou**: 2 Chinese navigation satellites
- ✓ **TBD Starlink 2, 3, 4**: SpaceX Falcon 9 rocket launches of 3rd, 4th and 5th batches of approx 60 satellites each for SpaceX's Starlink broadband network
- **NET Dec GPS 3-03**: a SpaceX Falcon 9 rocket will launch the U.S. Air Force's third generation 3 navigation satellite for the GPS
- ✓ **NET Dec Crew Dragon In-Flight Abort Test**: a SpaceX Falcon 9 rocket will launch Dragon on its In-Flight Abort test; later, its 1st commercial test flight with astronauts to the ISS in 2020
- **Jan 15 Eutelsat Konnect & GSAT 30**: an Ariane rocket will launch these comm. satellites to provide internet to Africa and India, respectively

NET: No Earlier Than



Holiday Astro Calendar



December 2019

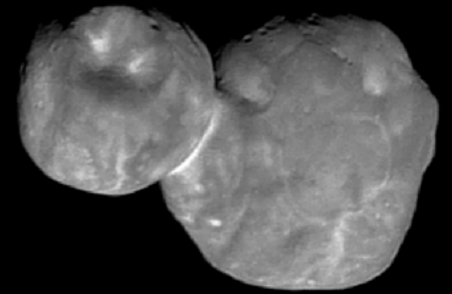
< Today >

| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|--|--|--|---|---|---|--|
| 50 8 John Glenn d. 2016 @ 95 yr | 9 | 10 Venus 2° S of Saturn 6:00 pm (7° Alt @ SW) | 11 Cold 🥶 Moon 12:12 am H. Leavitt d. 1921 @ 53 yr Cepheids | 12 Russell Porter b. 1871 Stellafane | 13 Geminids [peak 7pm] T. Brahe d. 1546 | 14 |
| 51 15 Moon 5° W of Beehive (M44) 3:00 am | 16 Moon Perigee 370,265 km 3:00 pm Proj Blue Book closed 1969 | 17 Last Qtr 11:57 pm | 18 Apollo 17 last to Moon 1972 | 19 Winter Solstice 11:19 pm | 20 C. Sagan d. 1996 | 21 Apollo 8 1st to Moon 1968 |
| 52 22 Ursids [peak 10pm] | 23 Mars 5.5° NW of @ 6:00 am (10° Alt @ E) | 24 Christmas Day Isaac Newton b. 1642 | 25 Boxing Day New 🌑 12:13 am | 26 Annular Solar Eclipse J. Kepler b. 1571 | 27 Venus 2.5° N of 6:00 pm (10° Alt @ SW) | 28 |
| 1 29 | 30 | 31 Moon Apogee 404,580 km 9:00 pm | Jan 1 New Year's Day | 2 First Qtr 11:45 pm | 3 Quadrantids [peak 3pm] Spirit 2004 1st Mars Rover | 4 |
| 2 5 Earth Perihelion 147,091,144 Km | 6 LRO Launched 1998 | 7 | 8 | 9 C. Herschel d. 1848 @ 97 yr | 10 Wolf 🐺 Moon 2:21 pm | 11 Moon 1° from Beehive (M44) 7:00 pm |
| 3 12 | 13 Moon Perigee 365,958 km 3:00 pm | 14 | 15 | 16 Penumbra Lunar Eclipse | 17 Last Qtr 7:58 am | 18 |

Year-End in Review



- **2 Solar Eclipses** (Total July 2nd; Annular Dec 26th)
- **Furthest Object Visited, Ultima Thule** (Jan 1st)
- **1st Soft Landing on Far Side, Chang'e-4** (Jan)
- Meteor "Photo-bombs" **Lunar Eclipse** (Total Jan 20th-21st)
- **Saw "shadow" of a Black Hole** (Apr 10th)
- NASA **Twins Study** shows how space affects Human Health (Apr)
- 50th Anniversary of **First Humans on Moon** (Jul)
- **Mercury Transit** (Nov 11th)
- **1st all Female Space Walk** by Jessica Meir and Christina Koch (Oct 18th)



New Years' Resolutions

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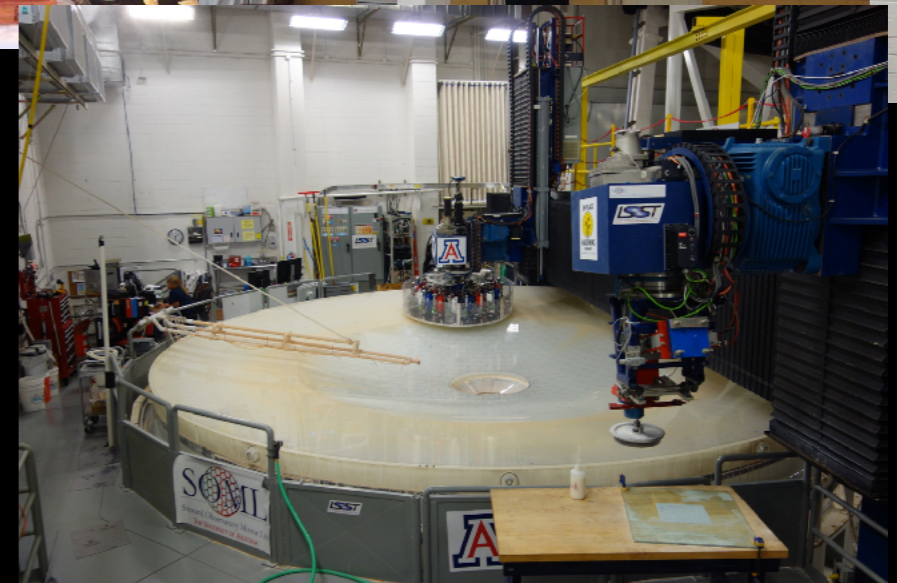
- **Jan 31st - Feb 16th: Own a Piece of Outer Space?**

- ✓ World's Largest Gem & Mineral Show in Tucson, AZ
- ✓ RFC Mirror Lab, Kitt Peak, Mt Lemmon and much more



- **Apr 4th - 5th: Relieve your G.A.S.!!**

- ✓ 30th Anniversary of NEAF in Suffern, NY - the World's Largest Astro Equipment Show
- ✓ Take train down to B&H Photo + Hayden Planetarium & Sci Ctr



New Years' Resolutions



- **Most Months: Reach for the Stars**



- ✓ Add a Star Party to your Vacation?
- ✓ Share your enthusiasm and inspire others at OSC, DDO, ...

New Years' Resolutions



- **Most Months: Reach for the Stars**

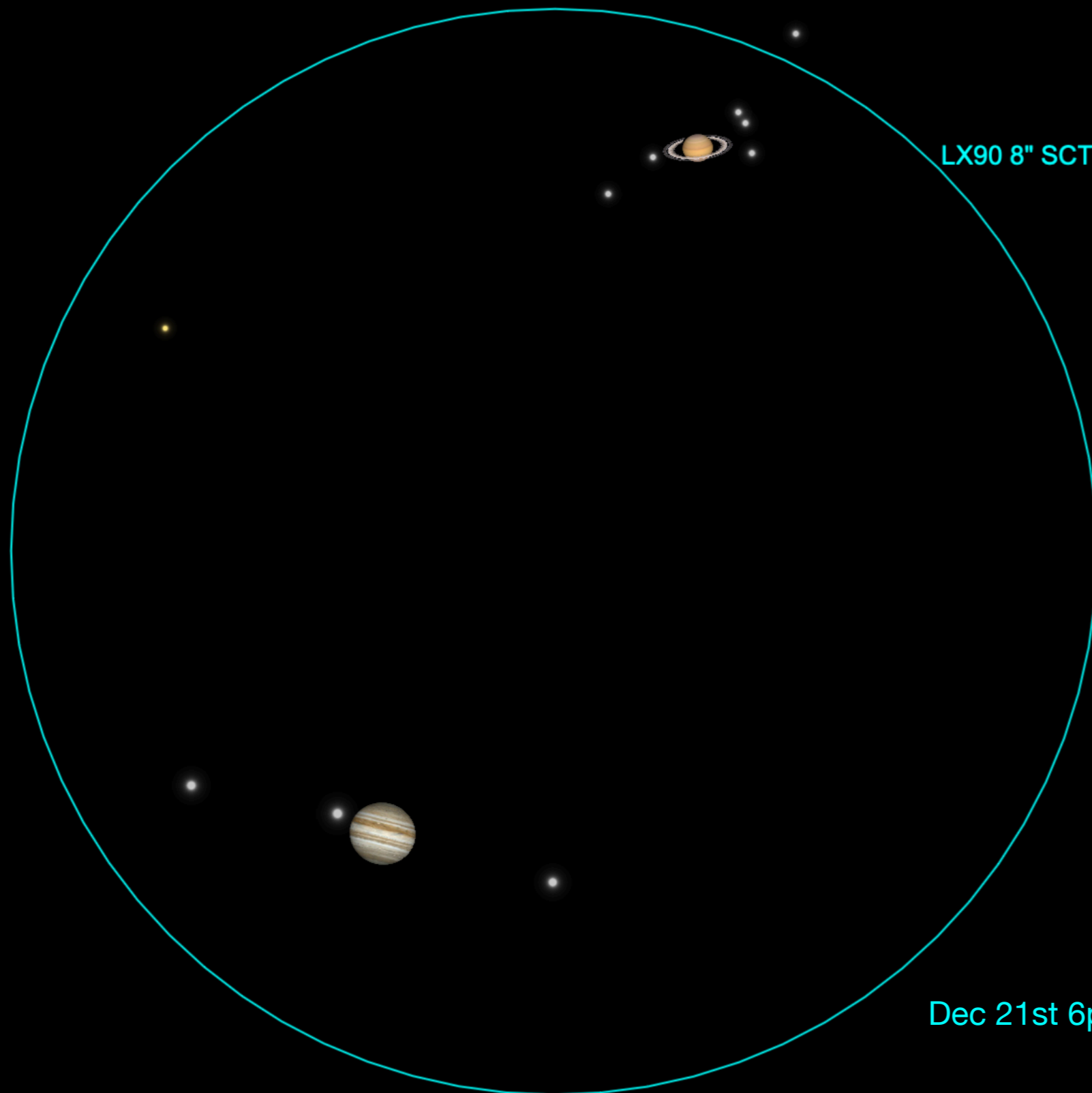


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- **Observing Delights:**

- ✓ Meteors: Lyrids Apr 22-23 (New Moon);
Perseids Aug 12-13 (Last Qtr Moon);
Geminids Dec 13-14 (\approx New Moon)
- ✓ Conjunctions: Rare Jupiter-Saturn on
Dec 21st (only 7 arc-min apart)

New Years' Resolutions



LX90 8" SCT, 3-6mm Zoom @ 6mm

Dec 21st 6pm Alt 8° FOV 9'

New Years' Resolutions



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- **Dec 14th: Experience the Awesome!!**

- ✓ Total Eclipse of the Sun in Chile or Argentina 🕶️ + ☀️



References



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- Birren, Peter, *Objects In The Heavens (OITHv5)*, <http://www.birrendesign.com/astro.html> in PDF or "pocket" book. Excellent! Objects to 10th Mag by constellation, plus handy ref lists, moon phases
- Occultations:
 - <https://occultations.org/observing/occultation-predictions/> Lunar and Asteroid Occultations (incl. RASC data)
 - <http://www.asteroidoccultation.com> (Steve Preston); <http://www.randomadventures.com/asteroidoccultations.html> (for Google map)
- <http://www.planetary.org/multimedia/space-images/charts/whats-up-in-the-solar-system-frohn.html> by Olaf Frohn, Map of Space Missions
- <https://www.spaceflightinsider.com/launch-schedule/> <https://spaceflightnow.com/launch-schedule/> <https://www.spacelaunchschedule.com/launch-schedule/> Space Launches and Missions
- <http://www.skymaps.com> for monthly star chart, observing highlights & visual/bino/telescope targets

Happy Holidays & Best Wishes for the New Year

Holiday Edition ©



Clear Skies!