Snake River Skies

The Newsletter of the Magic Valley Astronomical Society

www.mvastro.org

Membership Meeting

Saturday, October 12th 2019
7:00pm at the
Herrett Center for Arts & Science
College of Southern Idaho.

Public Star Party follows at the Centennial Observatory

Club Officers

Robert Mayer, President
mayerrbrt@gmail.com

Gary Leavitt, Vice President
leavittg@cableone.net

Dr. Jay Hartwell, Secretary

Jim Tubbs, Treasurer / ALCOR
jtubbs015@msn.com
208-404-2999

David Olsen, Newsletter Editor
editor@mvastro.org

Rick Widmer, Webmaster
rick@developersdesk.com

Magic Valley Astronomical Society is a member of the Astronomical League

M-51 imaged by
Rick Widmer &
Ken Thomason
Herrett Telescope
Shotwell Camera

MVAS President's Message

October 2019

The month of September started with the moon, both India's valiant effort that fell short in successfully landing a rover, and images from members of MVAS of the second brightest light in the sky. Those images were part of a flurry of activity started by the late August star party at the Oregon Trail Overlook at the Hagerman Fossil Beds National Monument. As I write this, we still don't know if the weather will allow us to go to the Craters of the Moon National Monument and land more pictures for the last weekend of September, but hopefully images and Hagerman will pop up again for us in October.

First, this month's meeting will feature a tradition and a required event. We'll again put on the annual MVAS Year-in-Pictures show, but before that, we will hold our annual officers' election. Please contact me about either pictures or nominations by Friday, Oct. 11. Our meeting itself will be the next day, Saturday, Oct. 12th, at 7 p.m. in the Rick Allen Room of the Herrett Center.

Later in the month, we hope to return to Hagerman, this time for a public viewing on Oct. 26th. The Hagerman site is becoming a more promising site than the Jerome Gun Club, and based on the summer star party's attendance, brings out some of our best visitors. We hope to see you there.

Until then,

Clear views,

Rob Mayer

Calendar

October 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5 First Quarter Moon  International Observe the Moon Night / Fall Astronomy Day
6	7	8	9	10	11	12 MVAS Meeting at 7:00pm at the Herrett Center Public Star Party Centennial Obs. 9:45p - 12:00a
13 Full Moon 100% Visible  Hunter's Moon	14 Columbus Day Thanksgiving Day - Canada 	15	16	17	18	19
20	21 Last Quarter Moon  Visible: 51% ↓ Age: 22.13 days	22	23	24	25	26 Hagerman Star Party Time TBA 
27	28 New Moon  Lunation 1198	29	30	31 Halloween 		

Snake River Skies is the Newsletter of the Magic Valley Astronomical Society and is published electronically once a month.
 Full Moon names follow the traditional Algonquin First Nation history.

Be Careful – Be Safe – Get Out There – Explore Your Universe

October Celestial Calendar by Dave Mitsky

All times, unless otherwise noted, are UT (subtract four hours and, when appropriate, one calendar day for EDT)

10/2 Pluto is stationary at 21:00
10/3 Mercury is at aphelion today; Venus is 3 degrees north of the first-magnitude star Spica (Alpha Virginis) at 1:00; the Moon is 7.3 degrees north of Antares (Alpha Scorpii) at 7:00; the Moon is 1.9 degrees north of Jupiter at 20:00
10/5 First Quarter Moon occurs at 16:47; the Moon is at the descending node (longitude 283.2 degrees) at 19:00; the Moon is 0.3 degrees south of Saturn, with an occultation taking place in southern Africa, southern Georgia, southern South America, and Easter Island, at 21:00
10/6 The Lunar X, also known as the Purbach or Werner Cross, an X-shaped illumination effect involving various rims and ridges between the craters La Caille, Blanchinus, and Purbach, is predicted to be visible at 4:17; the Moon is 0.1 degree south of Pluto, with an occultation taking place in western Polynesia, southeastern Micronesia, Melanesia, and Australia, at 9:00
10/7 The Martian northern hemisphere summer solstice occurs at 9:00
10/8 The peak of the Draconid meteor shower (10 to 30 per hour) occurs at 21:00
10/10 A double Galilean shadow transit begins at 10:55; the Moon is at apogee, subtending 29' 26" from a distance of 405,899 kilometers (252,214 miles), at 18:29; the Moon is four degrees south of Neptune at 23:00
10/13 Asteroid 19 Amphitrite (magnitude +8.7) is at opposition in Pisces at 8:00; Full Moon, known as the Blood or Sanguine Moon, occurs at 21:08; a double Galilean shadow transit begins at 23:53
10/15 The Moon is 4 degrees south of Uranus at 0:00
10/17 The Moon is 7.4 degrees south of the bright open cluster M45 (the Pleiades or Subaru) in Taurus at 4:00
10/19 The Moon is 1.7 degrees south of the bright open cluster M35 in Gemini at 15:00
10/20 Mercury is at greatest eastern elongation (24.6 degrees) at 4:00; the Moon is at the ascending node (longitude 101.4 degrees) at 7:00; the Moon is 3.3 degrees north of the first-magnitude star Regulus (Alpha Leonis) at 20:00
10/21 Last Quarter Moon occurs at 12:39
10/22 The peak of the Orionid meteor shower (15 per hour) occurs at 0:00; the Moon is 0.7 degree north of M44 (the Beehive Cluster or Praesepe) in Cancer at 5:00; the Curtiss Cross, an X-shaped illumination effect located between the craters Parry and Gambart, is predicted to be visible at 5:16
10/23 Mercury is at greatest heliocentric latitude south today; the Sun is at longitude 210 degrees at 17:00
10/25 Venus is at the descending node through the ecliptic plane at 2:00; asteroid 9 Metis (magnitude +8.6) is at opposition in Cetus at 21:00
10/26 The Moon is at perigee, subtending 33' 04" from a distance of 361,311 kilometers (224,508 miles), at 10:39; the Moon is 5 degrees north of Mars at 17:00
10/27 The Moon is 7 degrees north of Spica at 12:00
10/28 New Moon occurs (lunation 1198) at 3:38; Uranus is at opposition (magnitude +5.7, apparent size 3.7") at 8:00
10/29 Venus is 4 degrees south of the Moon at 14:00
10/30 Mercury (magnitude +0.5) is 3 degrees south of Venus (magnitude -3.9) at 8:00; the Moon is 7.1 degrees north of Antares at 16:00
10/31 The Sun enters Libra, at longitude 217.8 degrees on the ecliptic, at 13:00; the Moon is 1.3 degrees north of Jupiter at 14:00; Mercury is stationary at 20:00

Ejnar Hertzsprung and Henry Norris Russell were born this month.

The first recorded solar eclipse took place on October 22, 2136 BCE. Supernova SN 1604 (Kepler's Supernova) became visible to the naked-eye on October 9, 1604. Giovanni Cassini discovered Saturn's odd satellite Iapetus on October 25, 1671. M51a (the Whirlpool Galaxy) was discovered by Charles Messier on October 13, 1773. William Lassell discovered Triton, Neptune's brightest satellite, on October 10, 1846. Maria Mitchell discovered Comet C/1847 T1 (Miss Mitchell's Comet) on October 1, 1847. Asteroid 8 Flora was discovered by John Russell Hind on October 18, 1847. Two of the satellites of Uranus, Ariel and Umbriel, were discovered by William Lassell on October 24, 1851. Edwin Hubble discovered Cepheid variable stars in M31 (the Andromeda Galaxy) on October 5, 1923. Charles Kowal discovered 2060 Chiron, the first Centaur asteroid, on October 18, 1977. Michel Mayor and Didier Queloz announced the discovery of the exoplanet 51 Pegasi b (Dimidium) on October 6, 1995.

The Sun, the Moon, & the Planets

The Moon is 2.5 days old, subtends 32.7 arc minutes, is illuminated 7.2%, and is located in Libra on October 1st at 0:00 UT. The Moon reaches its greatest northern declination (+22.9 degrees) on October 20th and its greatest southern declination (-22.7 degrees) on October 6th. Longitudinal libration is at a maximum of +7.9 degrees on October 4th and a minimum of -6.1 degrees on October 20th. Latitudinal libration is at a maximum of +6.6 degrees on October 13th and a minimum of -6.5 degrees on October 27th. The smallest Full Moon of the year occurs on October 13th. New Moon occurs on October 28th. The Moon is at apogee (a distance of 63.64 Earth-radii) on October 10th and at perigee (a distance of 56.65 Earth-radii) on October 26th. The Moon occults Saturn from some parts of the world on October 5th and Pluto from some parts of the world on October 6th. Consult http://www.lunar-occultations.com/iota/planets/planets.htm and http://www.lunar-occultations.com/iota/bstar/bstar.htm for further information on lunar occultation events. Visit http://saberdoesthestars.wordpress.com/2011/07/05/saber-does-the-stars/ for tips on spotting extreme crescent Moons and http://www.curtrenz.com/moon06.html for Full Moon data. Click on https://www.calendar-12.com/moon_calendar/2019/october for a lunar phase calendar for this month. Times and dates for the lunar crater light rays predicted to occur in September are available at http://www.lunar-occultations.com/rlo/rays/rays.htm

The Sun is located in Virgo on October 1st at 0:00 UT. It enters Libra at 13:00 UT on October 31st.

Brightness, apparent size, illumination, distance from the Earth in astronomical units, and location data for the planets and Pluto on October 1st: Mercury (magnitude -0.2, 5.3", 86%, 1.28 a.u., Virgo), Venus (magnitude -3.9, 10.0", 98%, 1.66 a.u., Virgo), Mars (magnitude +1.8, 3.5", 100%, 2.64 a.u., Virgo), Jupiter (magnitude -2.0, 35.8", 99%, 5.51 a.u., Ophiuchus), Saturn (magnitude +0.5, 16.8", 100%, 9.88 a.u., Sagittarius), Uranus (magnitude +5.7, 3.7", 100%, 18.85 a.u. on October 16th, Aries), Neptune (magnitude +7.8, 2.3", 100%, 29.12 a.u. on October 16th, Aquarius), and Pluto (magnitude +14.3, 0.1", 100%, 33.92 a.u. on October 16th, Sagittarius).

This month Mercury, Venus, and Jupiter are located in the southwest, Saturn in the south, Uranus in the east, and Neptune in the southeast during the evening. At midnight, Uranus and Neptune can be found in the southwest. Mars is in the east and Uranus is in the west in the morning sky.

Mercury is at **aphelion** on October 3rd. The speediest planet reaches greatest eastern elongation on October 20th and greatest heliocentric latitude south on October 23rd. Mercury is three degrees south of Venus on October 30th. It is visible low in the south at twilight. Southern hemisphere observers will have a more favorable view.

The separation of **Venus** from the Sun increases from 13 degrees on October 1st to 21 degrees by October 31st but the planet remains low in the sky at sunset. Venus and Mercury grow closer to one another as October progresses. On October 29th, Mercury is positioned three degrees to the lower left of Venus and six degrees directly below the two-day-old crescent Moon, while Venus is five degrees to the lower right of the Moon. Once again observers in the southern hemisphere are favored.

Mars increases very slightly in apparent size this month but remains constant in brightness at magnitude +1.8. The Red Planet crosses southward over the celestial equator on October 7th. Set your alarm clock to wake early and go see a very slender crescent Moon, the star Porrima, and the planet Mars low over the eastern horizon before sunrise. After some time lost in the sun's glare, Mars makes its return to the sky this month. The planet is tiny, not much bigger than Uranus in a telescope, and relatively faint at magnitude +1.8. Binoculars will help you take it all in. Mars will rise a little earlier each day for the rest of the year and into 2020. It next reaches opposition nearly a year from now on October 13, 2020.

Jupiter fades slightly to magnitude -1.9 and decreases in apparent size by 2.3 arc seconds this month. It sets about 2.5 hours after the Sun sets by the end of October. The waxing crescent Moon passes less than two degrees north of Jupiter on October 3rd and October 31st.

Saturn is almost 30 degrees in altitude at dusk in early October and sets around midnight. By the end of the month, it sets shortly after 10:00 p.m. local time. Saturn reaches eastern quadrature on October 7th. The Ringed Planet's disk is some 16 arc seconds in angular diameter in mid-October. Its rings measure 37 arc seconds and are inclined 25.2 degrees. Titan is north of Saturn on October 1st and October 17th and south of it on October 9th and October 25th. Iapetus lies 8.5 arc minutes from Saturn and shines at tenth magnitude when it reaches greatest western elongation on the night of October 1st. It dims to eleventh magnitude on October 22nd when it passes 1.3 arc minutes north of Saturn. For further information on Saturn's satellites, browse http://www.skyandtelescope.com/observing/interactive-sky-watching-tools/

Uranus lies three degrees southwest of the sixth-magnitude star 19 Arietis this month. The waning gibbous Moon passes four degrees south of the ice giant on September 15th. When Uranus reaches opposition on October 28th, it is 2.6 light hours from the Earth and shines at magnitude +5.7, which is bright enough to be visible from a dark site. Uranus will be 63 degrees above the southern horizon, the highest it's been since February 1962, just before 1:00 a.m. local time on the night of opposition. Visit http://www.bluewaterastronomy.info/resources/Maps/Charts-2019/09uranus_2019_1.pdf and http://www.nakedeyeplanets.com/uranus.htm for finder charts.

Neptune is positioned 0.7 degree west-southwest of the fourth-magnitude star Phi Aquarii on the first day of October. As the month ends, Neptune is located 1.3 degrees west-southwest of the star. The waxing gibbous Moon passes four degrees south of Neptune on September 10th. Browse http://www.bluewaterastronomy.info/resources/Maps/Charts-2019/10neptune_2019_1.pdf and http://www.nakedeyeplanets.com/neptune.htm for finder charts.

Articles on Uranus and Neptune with finder charts appear on pages 48 and 49 of the September 2019 issue of Sky & Telescope and on pages 52 to 55 of the October issue of Astronomy. Finder charts for Uranus and Neptune are also available online at https://s22380.pcdn.co/wp-content/uploads/WEB_UrNep_2019-2020_updated.pdf

The dwarf planet **Pluto** can be found near the Teaspoon asterism in northeastern Sagittarius at a declination of nearly -22.5 degrees. Finder charts are available at http://www.bluewaterastronomy.info/resources/Maps/Charts-2019/Pluto2019.jpg and on page 48 and 49 of the July 2019 issue of Sky & Telescope and on page 243 of the RASC Observer's Handbook 2019.

Asteroids

Asteroid 29 Amphitrite travels southeastward through Pisces this month. It shines at magnitude 8.7 when it reaches opposition on October 13th. Asteroid Metis (magnitude +8.6) is at opposition in Cetus on October 25th. Data on asteroid occultations taking place this month is available at http://www.asteroidoccultation.com/2019_10_si.htm and http://www.poyntsource.com/New/Global.htm

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Carbon Star

Notable carbon star for October: RZ Pegasi: Right Ascension 22 05 52 Declinaiton +33 30 24

Comets

Comet C/2018 W2 (Africano) glides southwestward through Pisces and Aquarius during October. The fading comet is located two degrees southwest of the fifth-magnitude star Kapp Piscium on the night of October 1st and two degrees northwest of the third-magnitude star Delta Aquarii on October 7th. Browse http://cometchasing.skyhound.com/ and http://www.aerith.net/comet/future-n.html for further information on comets visible this month. Other sources of information include https://theskylive.com/comets and http://www.shopplaza.nl/astro/

Meteors

The Draconid (formerly the Giacobinid) meteor shower peaks on the night of October 8th/9th. The Draconids are quite variable and have produced meteor storms in 1933 and 1946. Comet 21P/Giacobini-Zimmer is the parent comet of the Draconids. Consult http://earthsky.org/astronomy-essentials/everything-you-need-to-know-draconid-meteor-shower and page 50 of the October 2019 issue of Sky & Telescope for additional information on the Draconid meteor shower. The Southern Taurid shower, debris from Comet 2P/Encke, may produce five meteors per hour when it peaks on October

10th. The Orionid meteor shower peaks on the night of October 21st but is compromised by a waning crescent Moon. Orionid meteors are fragments of Comet 1P/Halley. Browse http://www.timeanddate.com/astronomy/meteor-shower/orionid.html or http://earthsky.org/astronomy-essentials/everything-you-need-to-know-orionid-meteor-shower for more on the Orionids.

Orbiting Earth

Information on the celestial events transpiring each week can be found at http://astronomy.com/skythisweek and http://www.skyandtel...ky-at-a-glance/

The Deep Sky

The famous eclipsing variable star Algol (Beta Persei) is at a minimum, decreasing in brightness from magnitude +2.1 to magnitude +3.4, on October 3rd, 5th, 8th, 11th, 14th, 17th, 20th, 23rd, 25th, 28th, and 31st. Consult page 50 of the October 2019 issue of Sky & Telescope for the minima times. On the night of October 2nd, Algol shines at minimum brightness (magnitude +3.4) for approximately two hours centered at 9:23 p.m. EDT (1:23 UT October 3rd). It does the same at 11:04 p.m. EDT (3:04 UT October 23rd) on the night of October 22th and 7:53 p.m. EDT (23:53 UT) on the night of October 25th. For more on Algol, see http://stars.astro.illinois.edu/sow/Algol.html and http://www.solstation.com/stars2/algol3.htm

Eighty-five binary and multiple stars for October: Struve 2973, Struve 2985, Struve 2992, Struve 3004, Struve 3028, Otto Struve 501, Struve 3034, Otto Struve 513, Struve 3050 (Andromeda); 29 Aquarii, 41 Aquarii, 51 Aquarii, 53 Aquarii, Zeta Aquarii, Struve 2913, Struve 2935, Tau-1 Aquarii, Struve 2944, Struve 2988, Psi-1 Aquarii, 94 Aquarii, 96 Aquarii, h3184, Omega-2 Aquarii, 107 Aquarii (Aquarius); Otto Struve 485, Struve 3037, 6 Cassiopeiae, Otto Struve 512, Sigma Cassiopeiae (Cassiopeia); Xi Cephei, Struve 2883, Struve 2893, Struve 2903, Krueger 60, Delta Cephei, Struve 2923, Otto Struve 482, Struve 2947, Struve 2948, Struve 2950, Struve 2984, Omicron Cephei, Otto Struve 502 (Cepheus); Otto Struve 459, h1735, Struve 2876, Otto Struve 465, Struve 2886, Struve 2894, h1756, Struve 2902, Struve 2906, 8 Lacertae, Otto Struve 475, 13 Lacertae, h1828, 16 Lacertae (Lacerta); Struve 2857, Struve 2877, 34 Pegasi, Struve 2908, Xi Pegasi, Struve 2958, Struve 2978, 57 Pegasi, Struve 2991, h1859, Struve 3007, Struve 3021, Otto Struve 504, Struve 3044 (Pegasus); Struve 3009, Struve 3019, Struve 3033 (Pisces); Eta Piscis Austrini, Beta Piscis Austrini, Dunlop 241, h5356, Gamma Piscis Austrini, Delta Piscis Austrini, h5371 (Piscis Austrinus); h5417, Delta Sculptoris, h5429 (Sculptor)
Seventy-five deep-sky objects for October: NGC 7640, NGC 7662, NGC 7686 (Andromeda); NGC 7180, NGC 7183, NGC 7184, NGC 7293, NGC 7392, NGC 7585, NGC 7606, NGC 7721, NGC 7723, NGC 7727 (Aquarius); Cz43, K12, M52, NGC 7635, NGC 7788, NGC 7789, NGC 7790, St12 (Cassiopeia); B171, B173-4, IC 1454, IC 1470, K10, Mrk50, NGC 7235, NGC 7261, NGC 7354, NGC 7380, NGC 7419, NGC 7510 (Cepheus); IC 1434, IC 5217, NGC 7209, NGC 7223, NGC 7243, NGC 7245 (Lacerta); NGC 7177, NGC 7217, NGC 7320 (the brightest galaxy in Stephan's Quintet), NGC 7331, NGC 7332, NGC 7339, NGC 7448, NGC 7454, NGC 7479, NGC 7619 (the brightest member of Pegasus I), NGC 7626, NGC 7678, NGC 7742, NGC 7769 (Pegasus); NGC 7541, NGC 7562, NGC 7611 (Pisces); IC 5156, IC 5269, IC 5271, NGC 7172, NGC 7173, NGC 7174, NGC 7176, NGC 7201, NGC 7203, NGC 7214, NGC 7221, NGC 7229, NGC 7314, NGC 7361 (Piscis Austrinus); NGC 7507, NGC 7513, NGC 7713, NGC 7755, NGC 7793 (Sculptor)

Top ten binocular deep-sky objects for October: M52, NGC 7209, NGC 7235, NGC 7243, NGC 7293, NGC 7510, NGC 7686, NGC 7789, NGC 7790, St12

Top ten deep-sky objects for October: K12, M52, NGC 7209, NGC 7293, NGC 7331, NGC 7332, NGC 7339, NGC 7640, NGC 7662, NGC 7789

Challenge deep-sky object for October: Jones 1 (PK104-29.1) (Pegasus)

The objects listed above are located between 22:00 and 24:00 hours of right ascension.

As October ends, the zodiacal light may be visible in the pre-dawn eastern sky from a dark site. Articles on the zodiacal light appear at http://www.atoptics.co.uk/highsky/zod1.htm and http://earthsky.org/astronomy-essentials/everything-you-need-to-know-zodiacal-light-or-false-dawn

A wealth of current information on solar system celestial bodies is posted at http://nineplanets.org/ and http://www.curtrenz.com/astronomy.html

Various events taking place within our solar system are discussed at http://www.bluewaterastronomy.info/styled-4/index.html

Information on the celestial events transpiring each week can be found at http://astronomy.com/skythisweek and http://www.skyandtelescope.com/observing/sky-at-a-glance/

Online data generators for various astronomical events are available at https://astronomynow.com/almanac/ and https://calsky.com/

Free star charts for the month can be downloaded at http://www.skymaps.com/downloads.html and https://www.telescope.com/content.jsp?pageName=Monthly-Star-Chart and http://whatsouttonight.com/

Data on current supernovae can be found at http://www.rochesterastronomy.org/snimages/

Finder charts for the Messier objects and other deep-sky objects are posted at https://freestarcharts.com/messier and https://freestarcharts.com/ngc-ic and http://www.cambridge.org/features/turnleft/seasonal_skies_october-december.htm

Telrad finder charts for the Messier Catalog and the SAC's 110 Best of the NGC are posted at http://www.astro-tom.com/messier/messier_finder_charts/map1.pdf and http://sao64.free.fr/observations/catalogues/cataloguesac.pdf respectively.

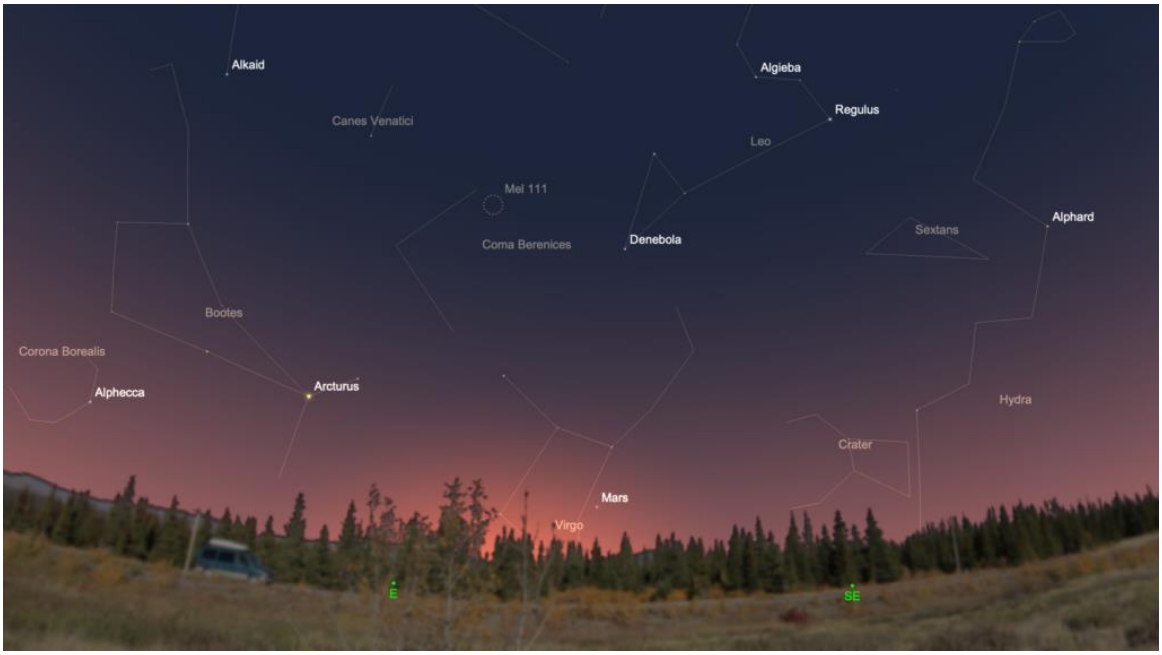
Information pertaining to observing some of the more prominent Messier galaxies can be found at http://www.cloudynights.com/topic/358295-how-to-locate-some-of-the-major-messier-galaxies-and-helpful-advice-for-novice-amateur-astronomers/

Author Phil Harrington offers an excellent freeware planetarium program for binocular observers known as TUBA (Touring the Universe through Binoculars Atlas), which also includes information on purchasing binoculars, at http://www.philharrington.net/tuba.htm

Stellarium and Cartes du Ciel are useful freeware planetarium programs that are available at http://stellarium.org/ and https://www.ap-i.net/skychart/en/start

Deep-sky object list generators can be found at http://www.virtualcolony.com/sac/ and http://tonightssky.com/MainPage.php and https://dso-browser.com/

Freeware sky atlases can be downloaded at http://www.deepskywatch.com/files/deepsky-atlas/Deep-Sky-Hunter-atlas-full.pdf and http://astro.mxd120.com/free-star-atlases



The *Voyager* Odyssey
Chapters 4-7: Mission Beginnings and Technical Specifications
by Loretta J Cannon

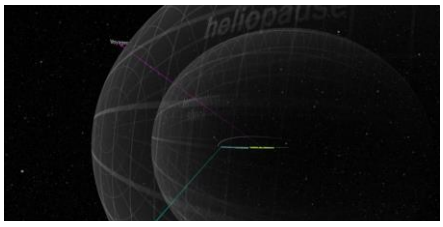
"We didn't want to build anything into the design that would have prevented us from going further. So, it was a mission within a mission."
- John Casani, Voyager Project Mgr
quoted in documentary *The Farthest Voyager in Space* (2017)

It was almost 54 years ago that an aeronautics graduate student at Caltech, Gary Flandro, took the first step towards the *Voyager* mission. In 1965 NASA was focused on planning the *Mariner 10* Venus-Mercury mission. The tragic *Apollo 1* mission was still two years away. Flandro's supervisor was involved in the *Mariner 10* mission, which would be using gravity-assist; he suggested that Flandro help explore the possibility of gravity-assist trajectories for theoretical outer solar system missions. His calculations revealed that a rare alignment of the four gas giants, on the *same* side of the solar system, would occur in the 1980s, *and* a single space probe launched in the mid-1970s could visit all of them in a single mission, shaving almost 20 years from a direct flight to Neptune. At JPL, the scenario was known as the "Grand Tour". Flandro even worked out the best date for a launch - the fall of 1977.


Dr. Gary Flandro (recent)
credit: Univ Tennessee Space Inst

By 1970, JPL's proposed "Grand Tour included two spacecraft launched in 1977 to explore Jupiter, Saturn and Pluto, while another two spacecraft launched in 1979 would explore Jupiter, Uranus and Neptune, all at a cost approaching $5.5 billion in today's dollars. President Nixon not only disapproved the "Grand Tour" but also cancelled *Apollo's 18-20* planned for 1973 and 1974. The previous year the nation had held its breath during the *Apollo 13* saga. *Apollo 14* wouldn't launch until 1971. But mission planners had been told that something less involved would be considered.

Click here [https://svs.gsfc.nasa.gov/4140] to watch a 2:08 simulation of *Voyager* trajectories. Once you start, watch it full screen and note the date/time clock running in the lower left of the screen.



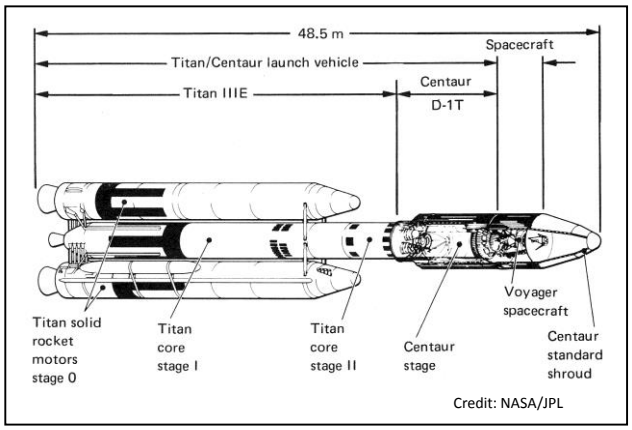
In 1972, the mission had been scaled back to only two spacecraft and two planets - Jupiter and Saturn and their moons - with a much lower price tag. Funding was approved. However, from the outset, mission planners built the spacecraft with an eye towards continuing the mission . . . if approved. It is also remarkable that the computer technology on the *Voyager* spacecraft, though state-of-the-art in 1972, is comparable to an Audi key fob. And both spacecraft are *still* transmitting data home (read on for details).

In 1977, the spacecraft were launched, after countless hours of work by countless individuals at multiple facilities, though not without some hiccups and some heart-stopping glitches. Just months before the spacecraft were to be sent to the Cape for launch, the mission engineers learned, from analyzed *Pioneer 10* data, that Jupiter's magnetic field was more intense than previously thought; some were predicting up to 40,000 volts could be encountered. This would fry the spacecraft's electronics. According to Frank Locatell, a project engineer, they bought a LOT of aluminum foil from local stores and, after carefully cleaning with alcohol and such, wrapped all the external cabling to ground them. Reynolds Wrap to the rescue. And while *we* know their efforts were successful, they wouldn't know for *two years* whether their last-minute efforts were enough to salvage the mission at Jupiter.

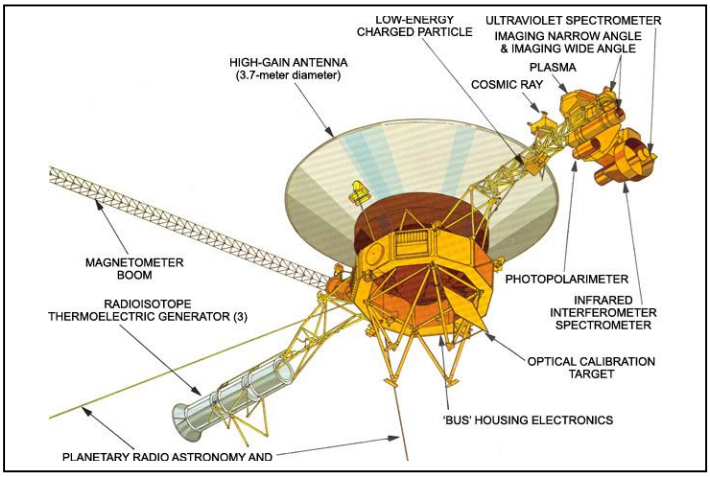
The big heart-stopper began during the launch of *Voyager 2* on August 20, 1977 (remember that *V2* went up first). The liftoff went without a hitch. But as the Titan-Centaur rocket blasted upwards, the spacecraft (as a passenger on that rocket) reacted as if something horrendous was happening, turning off systems, switching to backup systems, trying to correct its flight, but it couldn't. The ground-based engineers feared the mission might be lost. Eventually, a programmer explained that *Voyager* was operating within its parameters, parameters that turned out to be too narrow to allow for the forces of a rocket launch.


Voyager 2 launch Credit: NASA/JPL

They had less than a month to alter programming on *Voyager 1* to avoid another heart-stopper. The September 5th liftoff went well; the spacecraft tolerated the shaking. But then something different went wrong, horribly wrong. There was a leak in the propellant line on the Titan second-stage rocket. It ran out of fuel before it could deliver the thrust required to achieve a Jupiter destination. This left the Centaur upper stage to make up the difference. The Centaur was primarily responsible for guidance so it would have to burn longer, both to place the spacecraft on the correct trajectory AND to provide enough thrust to achieve the velocity needed to ensure reaching Jupiter. This meant the Centaur would have to use up to 1,200 pounds of extra propellant. When the engine finally cut out, as determined by the onboard computer, there was a mere 3.5 seconds of thrust (fuel) left in the tanks. << whew >>
They could take the next two years to recover before the excitement began as Jupiter came into view.



The *Voyager* spacecraft folded up nicely to fit into its compartment in the Centaur rocket. Unfolded, fully extended, the craft measures 8.5 meters (~28 ft) from the instrument boom shown upper left to the 3-part nuclear (radioisotope) generator at lower right. The (low field) magnetometer boom extends 13 meters while the planetary radio astronomy and the plasma wave antennas extend 10 meters each. Not identified in the graphic are the sixteen hydrazine thrusters located around the 'bus'. These came in handy when scientists were planning camera shots during the Uranus and Neptune flybys in the dark edges of the solar system.



At launch, each spacecraft had ten instruments active: cosmic ray subsystem, low-energy charged particle detector, magnetometer, plasma wave subsystem, plasma science, imaging science subsystem, photopolarimeter subsystem, infrared interferometer spectrometer and radiometer, planetary radio astronomy, ultraviolet spectrometer. As the spacecraft left the plane of the solar system, heading for interstellar space, some of the instruments were turned off as they were no longer needed to conserve power. Currently, only five of the instruments are active for the *Voyager Interstellar Mission*: cosmic ray subsystem, low-energy charged particle detector, magnetometer, plasma wave subsystem, plasma science (*V2* only). NASA's current *Voyager* mission status webpage [https://voyager.jpl.nasa.gov/mission/status/] depicts these instruments. The graphic shown is from this site. Below the instrument status section is the "Where are the Voyagers now?" section. By clicking on the [VIEW VOYAGER] button, you can explore the NASA Eyes on Solar System app. It is fun, though one doesn't learn 'where' the spacecraft are heading.

As reported in Chapter 3, *Voyager 1* is headed for the constellation Camelopardalis, and in about 40,000 years will drift past the star identified as AC+79 3888 in that constellation. Follow this link for a picture of that star: https://cdn.mos.cms.futurecdn.net/FcfaAN2PxM5UVLKqqT4oH8.jpg, though this author still doesn't know where to look for Camelopardalis. Meanwhile, *Voyager 2* is headed towards Sirius and will pass near in about 300,000 years.

Next month, we'll explore Neptune in November. Happy Halloween and Happy Stargazing.

[NOTE: This author deeply apologizes for the missing chapters over the summer. As a cautionary tale, *never* stand on a folding chair when you should use a step-ladder.

About the Author: Loretta is a 3rd generation Idahoan. She earned both of her Bachelor degrees from Boise banks, non-profits and the Federal government, she is somewhat retired and can be found devoting her time to science writing & editing and real estate. She can be reached at LorettaJCannon@gmail.com.

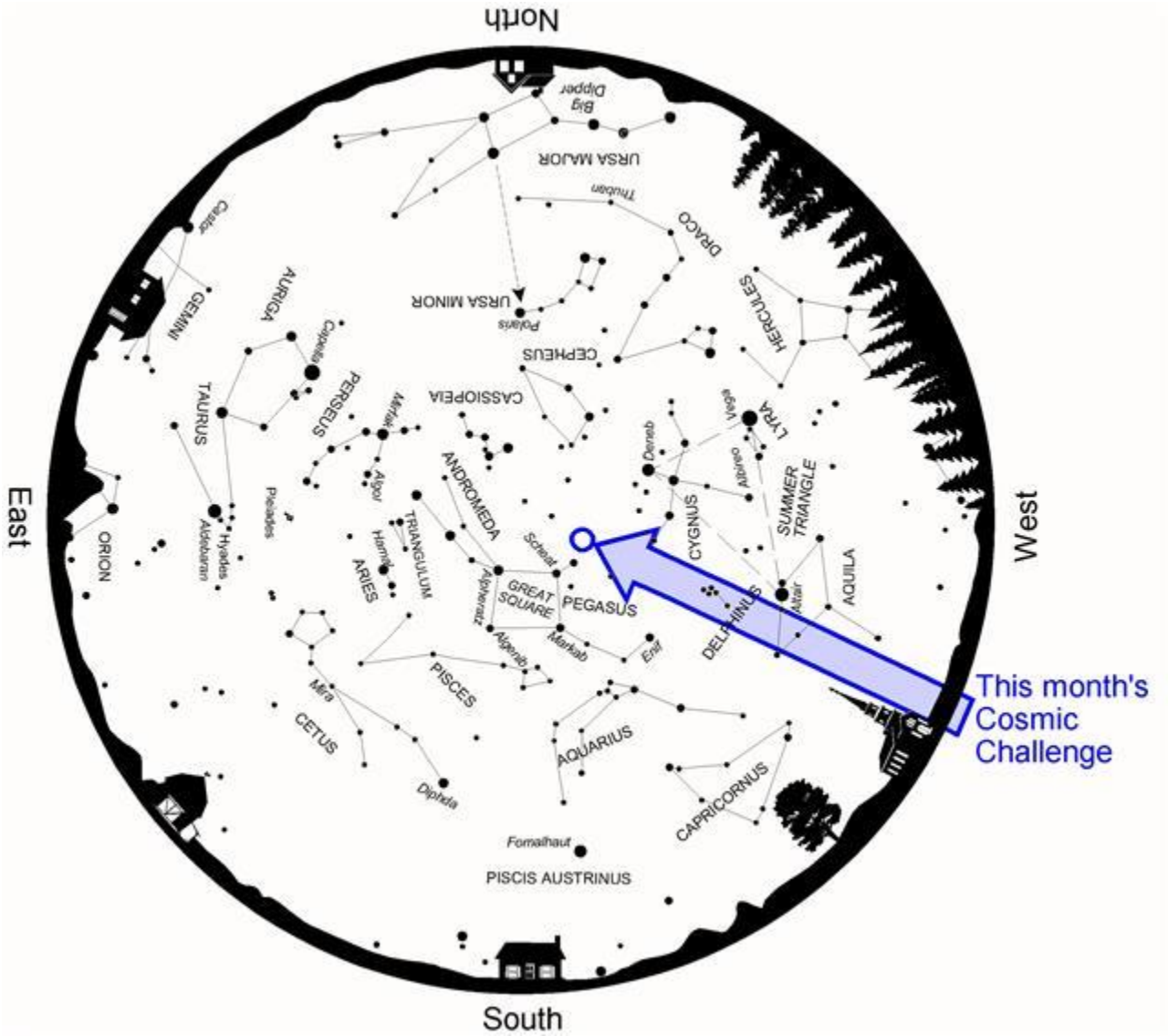
Phil Harrington's Cosmic Challenge

Cosmic Challenge: The Deer Lick Group

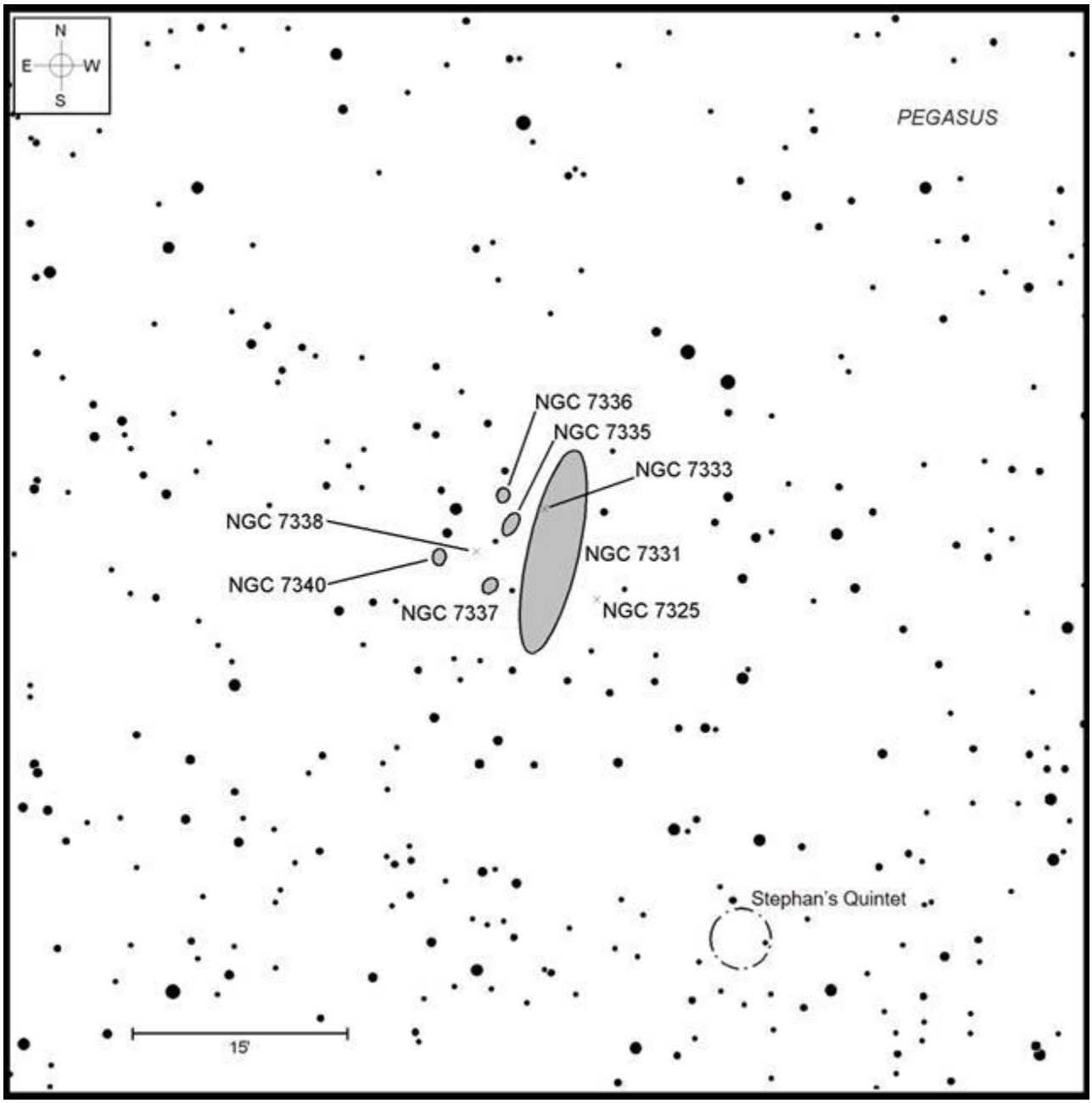
	6-inch (15.24 cm) to 9.25-inch (23.5 cm) telescopes.

Target	Type	RA	DEC	Constellation	Magnitude	Size
Deer Lick Group	Galaxy group	22h 37.3m	+34° 26.1'	Pegasus	--	~6' span

The autumn sky abounds with little bundles of galaxies scattered throughout its stars. One of the best known is the group of 7 galaxies that surround the magnificent spiral NGC 7331 in Pegasus, the Flying Horse. An observer could easily spend an hour or more just soaking in all that this small patch of sky has to offer.



Above: Autumn star map. Credit: Map adapted from Star Watch by Phil Harrington



Above: Finder chart for this month's Cosmic Challenge.
Click on the chart to open a printable PDF version.

NGC 7331 is reason enough to hunt down the group. Under dark skies, it makes a great challenge object for a pair of 50-mm binoculars. To find it, center on the star Matar [Eta (η) Pegasi]. Matar is often portrayed as one of the horse's front knees, just northwest of Sheat [Beta (β) Pegasi] in the Great Square. Look 5½°, or about a binocular field of view, to its north-northwest for a pair of orangish 6th-magnitude stars. Drop a degree back and NGC 7331 should be centered in view.

This galaxy takes on a life of its own through backyard scopes. At 84x, my 8-inch reflector shows an intense, perfectly circular galactic heart enveloped by the elongated whisper of the galaxy's spiral-arm halo, which is oriented north-south. Careful study through the same instrument at 119x reveals a subtle, mottled texture to the halo. As shown in the sketch below, a prominent dust lane along the western edge of the spiral-arm disk also comes into view and causes the core to appear slightly off-center. Can you make out any of the lane's blotchiness or hints of the spiral arms themselves that appear so prominently in photographs?

Four fainter galaxies are found just to the east of NGC 7331. Together, they collectively form the "**Deer Lick Group**." NGC 7331 represents the salt lick enticing the quartet of deer -- NGCs 7335, 7336, 7337, and 7340. In other circles, these four are known as "the Fleas," perhaps in search of a deer to call home.

Above: NGC 7331 surrounded by some of the Deer Lick Group galaxies as seen through the author's 8-inch (20cm) reflector Above: NGC 7331 surrounded by some of the Deer Lick Group galaxies as seen through the author's 8-inch (20cm) reflector.

Target	Type	RA	DEC	Magnitude	Size
NGC 7325	Double star	22 36.8	+34 22.0	14, 15	15"
NGC 7331	Galaxy	22 37.1	+34 25.0	9.4	14.5'x3.7'
NGC 7333	Single star	22 37.2	+34 26.0	15	--
NGC 7335	Galaxy	22 37.3	+34 26.9	14.4b	1.7'x0.7'
NGC 7336	Galaxy	22 37.4	+34 28.9	16.8	1.1'x0.4'
NGC 7337	Galaxy	22 37.4	+34 22.5	15.2p	1.3'x0.9'
NGC 7338	Double star	22 37.5	+34 24.8	14	--
NGC 7340	Galaxy	22 37.7	+34 24.6	14.7p	1.1'x0.7'

Fleas or deer notwithstanding, the most prominent of the four is NGC 7335, a tight-armed spiral spanning just 1' x 0.4'. Look for its faint, oval blur 3½' to the northeast of NGC 7331. NGC 7336 is situated 2' further north, on the other side of a 13th-magnitude field star. Spotting it through a telescope in the 6-to-9.25-inch range is difficult, if not impossible. Indeed, it puts up a valiant fight even through my 18-inch. Use averted vision to pick out its vague, elliptical form. If you have gifted vision, a top-notch telescope, and perfect conditions, you just might spy it.

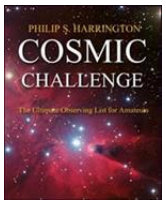
Southeast of NGC 7331's core is an obtuse triangle of three 13th-magnitude field stars. If you can find them, then you have also found the home of NGC 7337, just west of the triangle's apex star. Although its spiral arms span about an arc-minute, only the galaxy's very compact core will likely be detectable through amateur telescopes.

The easternmost deer, NGC 7340, strikes me as the second brightest. Its disk appears almost perfectly round, with just a hint of a brighter core. You'll find it just south of a second, brighter obtuse triangle of stars, this one oriented north-south.

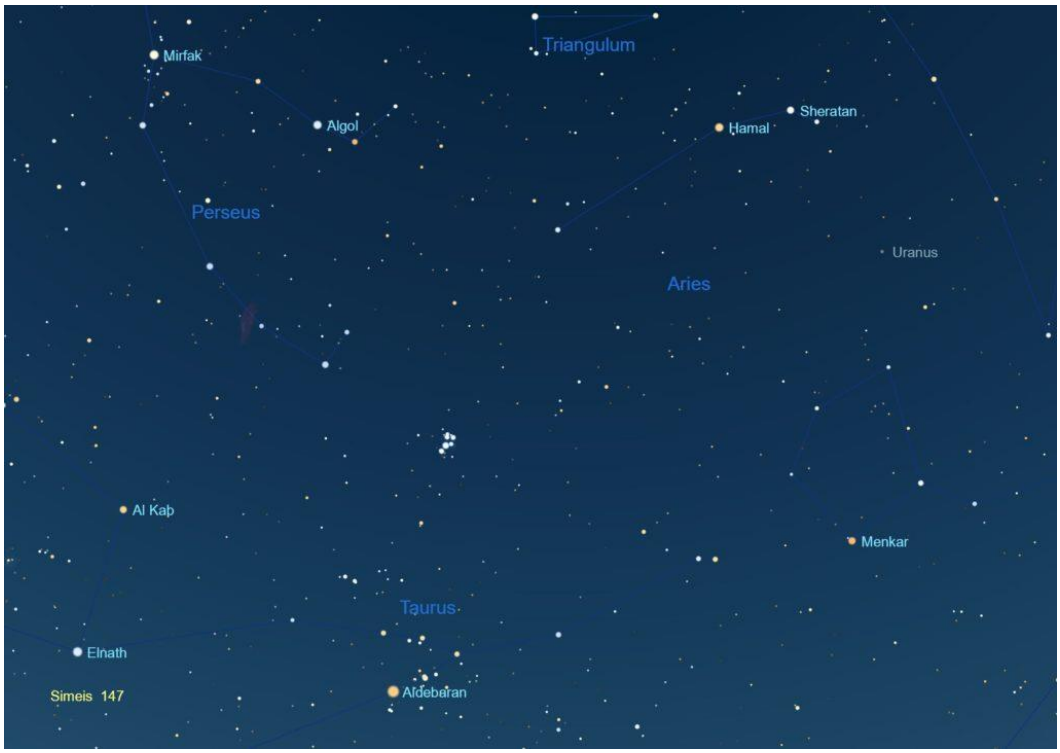
NGC 7331 may look like the mother duck, and the others all ducklings following in line, but in reality they are at far different distances away. NGC 7331 is estimated to lie 39.8 million light years from the Milky Way, while NGCs 7335, 7337, and 7340 are some 300 million light years away. The last, NGC 7336, is another 100 million light years further still. But NGC 7331 may not be a loner after all. Studies conducted in the mid-1990s indicate that NGC 7331 may be gravitationally associated with NGC 7320, a dim galaxy 5' to the southwest. NGC 7320 is a member of a most peculiar gang of galaxies known as Stephan's Quintet. Stephan's Quintet was our featured challenge in October 2017.

Incidentally, if you check the original New General Catalog, you will find five other entries in the immediate vicinity: NGCs 7325, 7326, 7327, 7333, and 7338. None is a distant galaxy, however. Rather, each is a misinterpreted close-set double star, a faint individual star, or perhaps a figment of a tired astronomer's imagination. Of these, NGC 7325 is the brightest of the "missing" deer, although it is nothing more than a very faint double set 4½' southwest of NGC 7331's core. Even its brighter component, shining at 14th magnitude, is beyond the grasp of many a backyard telescope.

Until next month, remember that half of the fun is the thrill of the chase. Game on!



About the Author: Phil Harrington writes the monthly *Binocular Universe* column in Astronomy magazine and is the author of 9 books on astronomy. Visit his web site at www.philharrington.net to learn more.



The approximate location of the planet Uranus (Upper Right) in late October 2019. For a larger map visit https://cosmicpursuits.com/wp-content/uploads/2019/10/Uranus-2019.jpg

This article is distributed by NASA Night Sky Network
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Find Strange Uranus in Aries

David Prosper

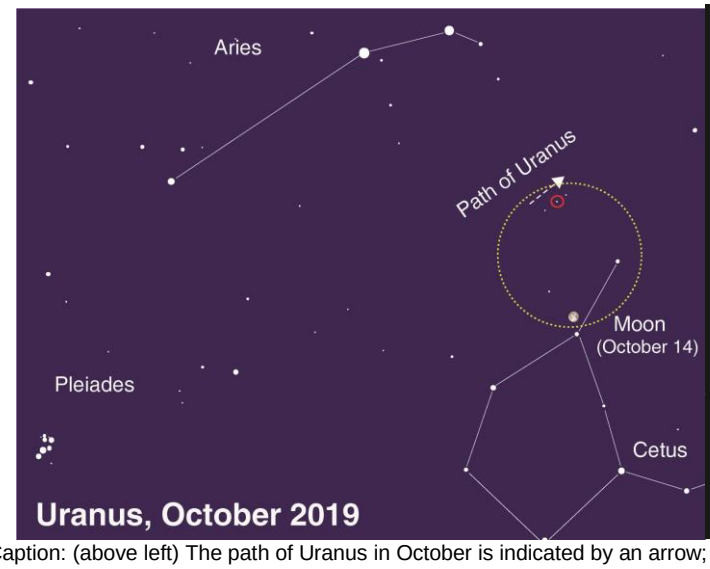
Most of the planets in our solar system are bright and easily spotted in our night skies. The exceptions are the ice giant planets: Uranus and Neptune. These worlds are so distant and dim that binoculars or telescopes are almost always needed to see them. A great time to search for Uranus is during its opposition on October 28, since the planet is up almost the entire night and at its brightest for the year.

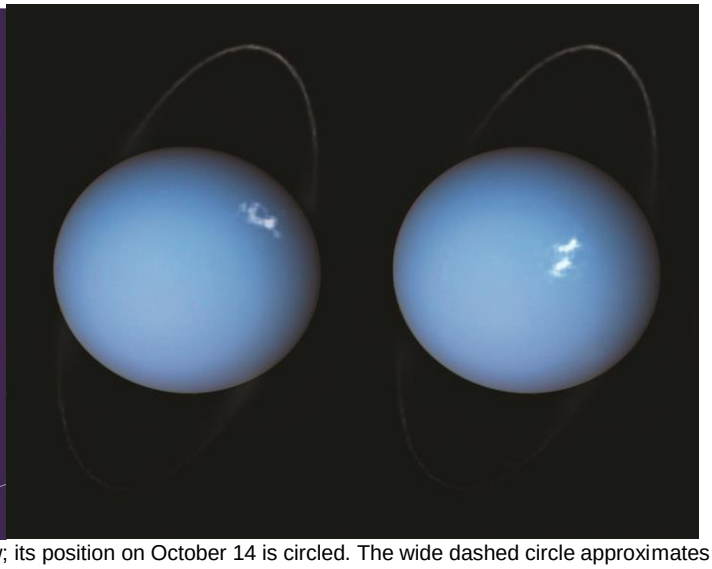
Search for Uranus in the space beneath the stars of Aries the Ram and above Cetus the Whale. These constellations are found west of more prominent Taurus the Bull and Pleiades star cluster. You can also use the Moon as a guide! Uranus will be just a few degrees north of the Moon the night of October 14, close enough to fit both objects into the same binocular field of view. However, it will be much easier to see dim Uranus by moving the bright Moon just out of sight. If you're using a telescope, zoom in as much as possible once you find Uranus; 100x magnification and greater will reveal its small greenish disc, while background stars will remain points.

Try this observing trick from a dark sky location. Find Uranus with your telescope or binoculars, then look with your unaided eyes at the patch of sky where your equipment is aimed. Do you see a faint star where Uranus should be? That's not a star; you're actually seeing Uranus with your naked eye! The ice giant is just bright enough near opposition - magnitude 5.7 - to be visible to observers under clear dark skies. It's easier to see this ghostly planet unaided after first using an instrument to spot it, sort of like "training wheels" for your eyes. Try this technique with other objects as you observe, and you'll be amazed at what your eyes can pick out.

By the way, you've spotted the first planet discovered in the modern era! William Herschel discovered Uranus via telescope in 1781, and Johan Bode confirmed its status as a planet two years later. NASA's Voyager 2 is the only spacecraft to visit this strange world, with a brief flyby in 1986. It revealed a strange, severely tilted planetary system possessing faint dark rings, dozens of moons, and eerily featureless cloud tops. Subsequent observations of Uranus from powerful telescopes like Hubble and Keck showed its blank face was temporary, as powerful storms were spotted, caused by dramatic seasonal changes during its 84-year orbit. Uranus's wildly variable seasons result from a massive collision billions of years ago that tipped the planet to its side.

Discover more about NASA's current and future missions of exploration of the distant solar system and beyond at nasa.gov





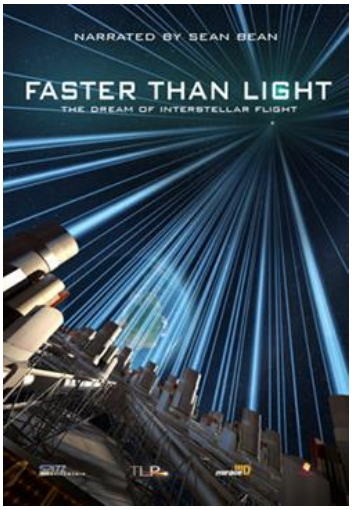
Caption: (above left) The path of Uranus in October is indicated by an arrow; its position on October 14 is circled. The wide dashed circle approximates the field of view from binoculars or a finderscope. Image created with assistance from Stellarium. Caption: (above right) Composite images taken of Uranus in 2012 and 2014 by the Hubble Space Telescope, showcasing its rings and auroras. More at bit.ly/uranusauroras Credit: ESA/Hubble & NASA, L. Lamy / Observatoire de Paris.

Observatory and Planetarium

Event	Place	Date	Time	Admission
Monthly Free Star Party	Centennial Observatory	Saturday, October 12th, 2019	7:30 PM to midnight	FREE

CSI Centennial Observatory / Faulkner Planetarium Herrett Center

College of Southern Idaho Campus Twin Falls, ID
Faulkner Planetarium / Show Times
http://herrett.csi.edu/astronomy/planetarium/showtimes.asp



Now Showing

3 of the shows showing at the Faulkner Planetarium. Visit the link above for show times.

About the Magic Valley Astronomical Society

Magic Valley Astronomical Society
550 Sparks St.
Twin Falls, ID

The Magic Valley Astronomical Society (MVAS) was founded in 1976. The Society is a non-profit [501(c) 3] educational and scientific organization dedicated to bringing together people with an interest in astronomy.

In partnership with the Centennial Observatory, Herrett Center, College of Southern Idaho - Twin Falls; we hold regularly scheduled monthly meetings and observation sessions, at which we share information on current astronomical events, tools and techniques for observation, astrophotography, astronomical computer software, and other topics concerning general astronomy. Members enthusiastically share their telescopes and knowledge of the night sky with all who are interested. In addition to our monthly public star parties we hold members only star parties at various locations throughout the Magic Valley.

MVAS promotes the education of astronomy and the exploration of the night sky along with safe solar observing through our public outreach programs. We provide two types of outreach; public star parties and events open to anyone interested in astronomy, and outreach programs for individual groups and organizations (e.g. schools, churches, scout troops, company events, etc.), setting up at your location. All of our outreach programs are provided by MVAS volunteers at no cost. However, MVAS will gladly accept donations. Donations enable us to continue and improve our public outreach programs.

Membership is not just about personal benefits. Your membership dues support the work that the Magic Valley Astronomical Society does in the community to promote the enjoyment and science of astronomy.
Speakers, public star parties, classes and support for astronomy in schoolrooms, and outreach programs just to name a few of the programs that your membership dues support.

Annual Membership dues will be:
$20.00 for individuals, families, and $10.00 for students.
Contact Treasurer Jim Tubbs for dues information via e-mail: jtubbs015@msn.com

Donations to our club are always welcome and are even tax deductible. Please contact a board member for details.

Membership Benefits:
Lending Telescopes: The society currently has three telescopes for loan and would gladly accept others please contact President Robert Mayer, for more information on these and other benefits.

Telescopes are an individual thing and not practical for public use. However, everyone should have the experience of a good look at the moon for at least 5 minutes in their life time. It is a dimension and feeling that is unexplainable. Pictures or TV can't give this feeling, awareness, or experience of true dimension. A person will not forget seeing our closest neighbor, the moon. Norman Herrett in a letter to Dr. J. L. Taylor, president of the College of Southern Idaho, Twin Falls, ID, USA.