EXTRA CONTENT, SKY FOR DECEMBER 2021

Below are some tips for "star hopping" to **Uranus and Neptune,** and some information about where to look for **Comet Leonard (C/2021 A1),** steeply descending in eastern morning sky with increasing speed through December 12, and very low in WSW to SW evening sky, beginning December 13. Magnitudes are provisional, and do not include the forward scattering enhancement, amounting to as much as 2 or 3 magnitudes Dec. 12-15.

Finder charts for Uranus and Neptune appear at https://skyandtelescope.org/observing/ice-giants-neptune-and-uranus/
Helpful wider angle charts of the sky surrounding Neptune and Uranus accompanied these closeup finder charts in the September and November 2021 issues of the magazine. Without those wider-angle charts, if you have a star atlas, you can still follow the star hopping instructions below.

Robert Victor

Star hops to Uranus and Neptune.

For **Uranus,** first use the "V" of Aldebaran and the Hyades (head of Taurus, the Bull) as an arrowhead pointing southwest to 2.5-mag. Alpha Ceti, brightest star in the head of Cetus. In clockwise order, the five stars in the pentagon-shaped head of Cetus are Alpha, Lambda, Mu, Xi-2, and Gamma. Mu, of mag. 4.3, is the northernmost star of the head of Cetus. You can refer to Chart 4 of Sky & Telescope's Pocket Sky Atlas, or a comparable star atlas chart, to follow this star hop to Uranus:

From 4.3-mag. Mu Ceti (Mu Cet), go 2.3° due north to 5.2-mag. 38 in Aries (38 Arietis, or 38 Ari). Next, from 38 Ari, go another 2.9° due north to 5.8-mag. Omicron Ari, which is 5.2° north of Mu Cet. Next, look 2.8° west and slightly south of Omicron Ari for a 6.0-mag. star, 29 Ari. It is almost as far west of Omicron Ari as 38 Ari is south of Omicron, so the three stars form a nearly isosceles triangle with Omicron at the vertex. The base of the triangle, from 38 Ari to 29 Ari, is 3.9 degrees, and its largest interior angle, at Omicron, is just shy of 90 degrees.

For most of December, Uranus, of mag. 5.7, lies within that triangle, just south of a line joining Omicron to 29. On December 1, Uranus lies 2.0° from Omicron and 0.9° from 29. On Dec. 31 and Jan. 1, Uranus lies 2.8° from Omicron and just over 0.4° south of 29. Uranus is retrograding until mid-January, and remains just over 0.4° from 29 from late December 2021 through early February 2022. Through most binoculars, Uranus is an easy find, and noticeably a bit brighter than 29 Ari. A telescope magnifying 100x or more will easily reveal Uranus' disk, 3.7 arcseconds across.

I could pick up Uranus easily with my compact 6.5 x 32mm binoculars, and it was very easy in my 10 x 70's. It should be easy in any 40mm or 50mm binoculars.

Neptune's field in Aquarius is plotted on Chart 76 of the Pocket Sky Atlas, or the corresponding chart of another star atlas. From Zeta Aquarii (Zeta Aqr) at the center of the "Y"-shaped Water Jar of Aquarius, go 10° to the southeast to 3.8-mag. Lambda Aqr. From Lambda, go 6°-7° ESE for an attractive, equally spaced compact triplet of stars, Psi-1, Psi-2, and Psi-3, "the Psi's", in order of position from NW to SE, and in order of brightness, magnitudes 4.2, 4.4, and 5.0, respectively. From 4.2-mag. Psi-1, the triplet's northernmost member, go about 3° nearly due north to 4.2-mag. Phi. (On your way from Psi-1 to Phi, you will pass 5.0-mag. Xi.)

In the same binocular field, between east and northeast of Phi, you will notice a pair of stars, each nearly 1.6° from Phi and forming an isosceles triangle with it. The two stars, 51 arcminutes (0.85°) apart, are 96 Aqr, the brighter and more northerly, at mag. 5.6; and HR 8879 (HD 220035), at mag. 6.2 and nearly due east of Phi.

Neptune ends retrograde on December 1, and thereafter creeps very slowly eastward, especially in the early part of the month. The 7.9-mag. planet also forms an isosceles triangle with 96 Aqr and HR 8879 all month, but unlike Phi, Neptune is east of the pair. On Dec. 1, Neptune is nearly 3.0° ENE of Phi, and 1.5° from 96 Aqr and HR 8879. On Dec. 16 and 17, Neptune is just over 3.0° ENE of Phi, and forms a rhombus with the three stars, with all four sides nearly 1.6°. On Jan. 2, 2022, Neptune will be 1.8° from 96 Aqr and HR 8879, and nearly 3.3° ENE of Phi.

In summary, to locate Neptune, start at 4.2-mag. Phi Aquarii, then shift your telescope through the "gateway" midway between 96 Aqr and HR 8879, and not much farther, and you'll arrive at the target planet. Use a high-power eyepiece to reveal the tiny disk, only 2.3 arcseconds across. In recent evenings, Neptune has been easy to spot with my 10x70 binoculars.

Comet C/2021 A1 (Leonard)

During Dec. 1-12, look for the comet in the morning sky, about one hour before sunrise, or earlier when the comet is faint. Use charts 44, 55, and 54 of Sky & Telescope's *Pocket Sky Atlas.*

Date	Approx. position	Provisional mag.
Dec. 2, 3	near M3, 50° up in E	6.4, 6.2
Dec. 5	6° N (upper left) of Arcturus	5.7
Dec. 6	5° left of Arcturus	5.5
Dec. 9	SW of Beta Ser	4.7
Dec. 10	lower left of Alpha Ser	4.5
Dec. 11	NE (left) of Lambda Oph	4.3
Dec. 12	Comet closest to Earth, distance 0.233 AU, rising in twilight lower left of Delta and Epsilon Oph.	4.2

Comet C/2021 A1 (Leonard)
In evening sky, begin looking on December 13, within one hour after sunset. Use charts 56, 67, and 66 of Sky & Telescope's *Pocket Sky Atlas.*

Dec. 13: Comet 15° from Sun, sets in bright twilight 13° S of W and 30° lower right of Venus. Maximum phase angle Sun-Comet-Earth = 160°, leading to maximum enhancement in brightness. Comet may shine at first magnitude instead of its predicted 4.2.

Date	Approx. Position	Provisional Mag.
Dec. 13	Closely SW of Nu Oph; sets early in twilight.	4.2
Dec. 14	Sets in twilight 22° LR of Venus	4.2
Dec. 15	Sets in twilight 14° LR of Venus; near bowl of "Teaspoon" (Pi, Omicron, Xi-2 Sgr)	4.3
Dec. 16	Sets near end of twilight; 8° LR of Venus. Earlier today, Comet Leonard crossed to south of ecliptic plane.	4.4
Dec. 17	5° below Venus	4.6
Dec. 18	6°-7° lower left of Venus; near "Territory of Dogs", a 2° by 1° kite-shaped asterism comprised of Omega, 59, 60, and 62 Sgr.	4.7
Dec. 19	9°-10° lower left of Venus.	4.8
Dec. 20	12° lower left of Venus.	5.0
Dec. 22	18° left of Venus.	5.2

Evening of Jan. 2 (Pacific Time): Comet passes perihelion, 0.615 AU from Sun. It will leave our solar system on a hyperbolic orbit, never to return.