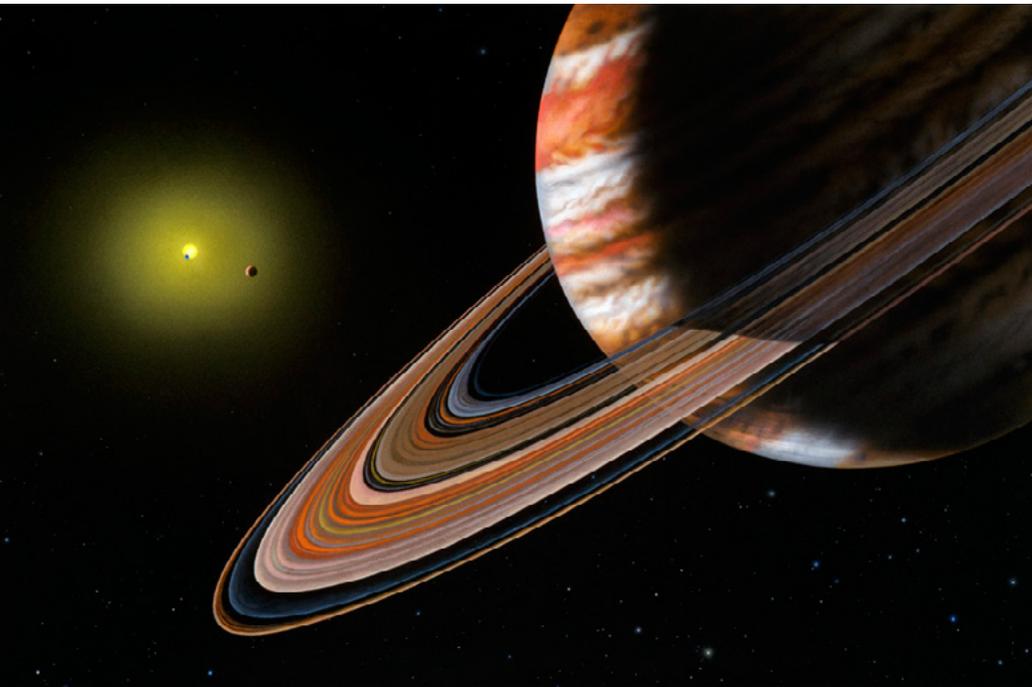




## UNIVERSE DISCOVERY GUIDES

October

# ARE ALL PLANET FAMILIES LIKE OURS?



Upsilon Andromedae's Family of Planets: Artist's concept. © 1999 Lynette Cook, all rights reserved. Art may not be used elsewhere without permission of the artist.

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The universe is a place of change. NASA missions advance our understanding of the changing universe.

[www.nasa.gov](http://www.nasa.gov)

## ARE ALL FAMILIES JUST LIKE YOURS?

Imagine if your family lived in a remote wilderness, far from other families. When you were young, all you knew about was your own family. You'd never met any others.

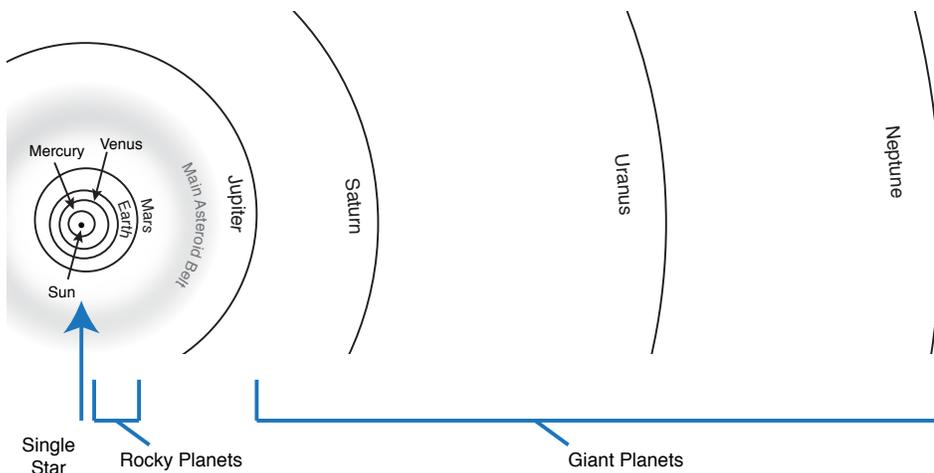
You might have assumed that all families probably resembled yours.

But when you started exploring and, for the first time, met another family, you were surprised to discover they were quite different from yours! The more families you came across, the more variety you found.

### Not all Planet Families are Alike Either

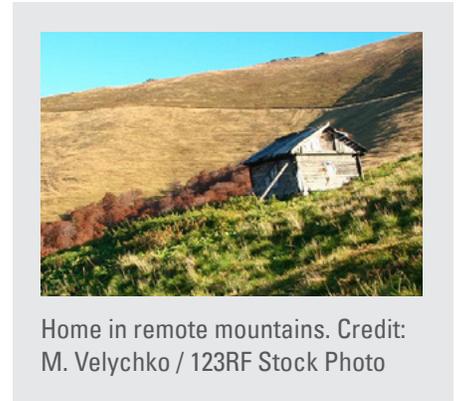
As scientists increase our understanding of the universe, the more varied and surprising we find it is.

When astronomers first started searching for planets around other stars, it was thought other stars' families of planets probably resembled the Sun and its planets: some small rocky planets close to the star and giant planets much farther out, all in roughly circular orbits, all in pretty much the same plane. It was also thought that stars orbiting companion stars, called binary stars, probably didn't have planets. Our Sun is a single star with no companion.



**Our Solar System.** Distances between the planet orbits are to scale. Credit: Astronomical Society of the Pacific

When astronomers started confirming planets orbiting other stars, what a surprise to discover the variety of planet families! All our assumptions about the characteristics of planet families were proved incorrect:



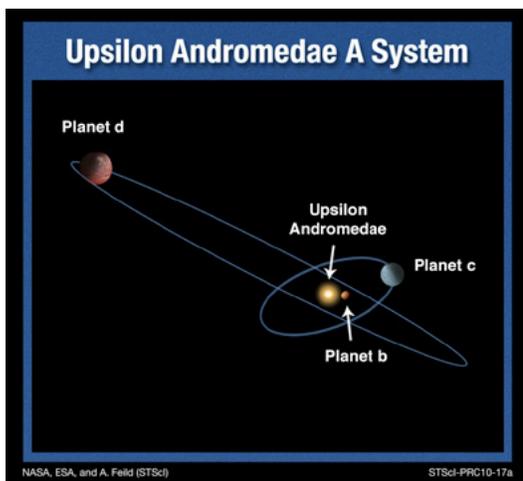
Home in remote mountains. Credit: M. Velychko / 123RF Stock Photo

- Some parent stars have giant gas planets like Jupiter (and larger) orbiting very close in — much closer than Mercury is to the Sun.
- Some planets have orbits more like comets that take them very close, then very far from the star.
- Others planets have orbits that are tilted relative to each other. In other words, the planets are not at all in the same plane.
- Even binary stars were found to have orbiting planets — planet families with two suns, like worlds in science fiction stories.

## Upsilon Andromedae: One of the Most Surprising of All

The planets orbiting a star named *Upsilon Andromedae* have **all** these unexpected characteristics.

*Upsilon Andromedae* was the first normal star confirmed to have multiple planets. It has gas giant planets orbiting in the same region where our Sun has only small rocky planets.



The orbit of one of its gas planets, designated as planet “d”, brings that planet close, then very far from the star. The planet cooks, then it freezes! This same planet orbits at a steep angle relative to the other planets.

Hubble Space Telescope data confirmed that the parent star has a companion red dwarf star orbiting it outside of the orbits of the planets — Upsilon Andromedae is a binary star. This planet family has two suns.

We have certainly discovered that other families, human and planet, can be quite different from our own!

## SKY FEATURE: UPSILON ANDROMEDAE

### How to Find it

**Distance:** 44 light-years

**Visual Magnitude:** 4.09

**To view:** Just your eyes under somewhat dark skies

[Click here to jump to the full-sky October Star Map.](#)

Upsilon Andromedae was the first normal star confirmed to have more than one orbiting planet. The star is fairly easy to find if you are away from bright city lights.

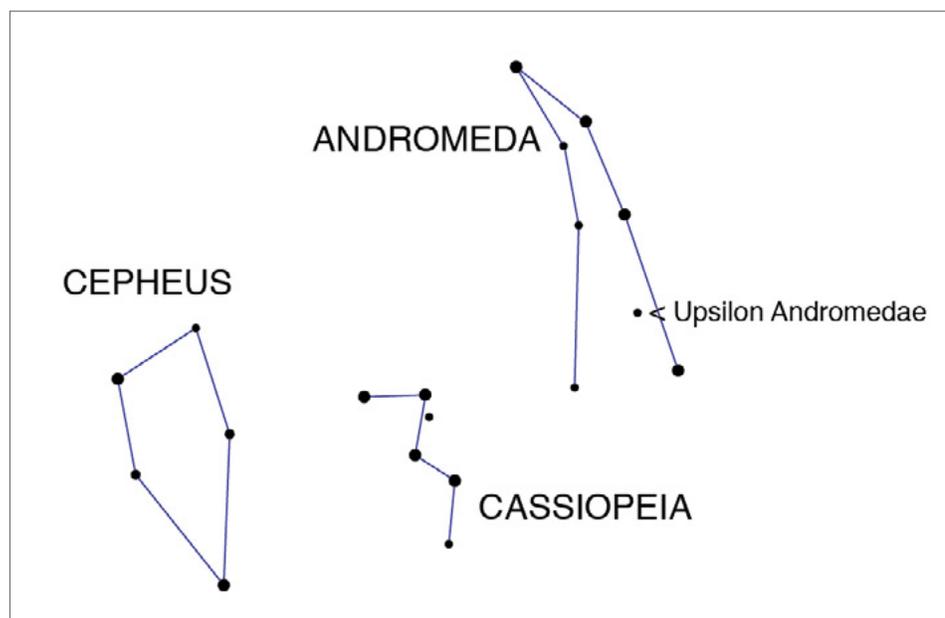
You can only see the star, not the planets orbiting it. The planets are too dim and too far away. It would be like trying to see a poppy seed next to a light bulb from about 300 miles away (about 500 km).

The star Upsilon Andromedae's family of planets is unusual. Zooming out to the entire constellation of Andromeda, we find it is part of a rather unusual family as well.

In ancient Greek stories, the constellation of Andromeda symbolizes the daughter of King Cepheus and Queen Cassiopeia, who are represented in nearby constellations. This legend, which includes a vengeful god of the sea, a huge monster and an adventurous prince, is arrayed out among the stars. You can search for the full story online.



Artist's concept of Upsilon Andromedae's Family of Planets. © 1999 Lynette Cook, all rights reserved. Art may not be used elsewhere without permission of the artist.



## TRY THIS!

The animation below shows some of the multiple-planet families discovered using NASA's Kepler Mission.

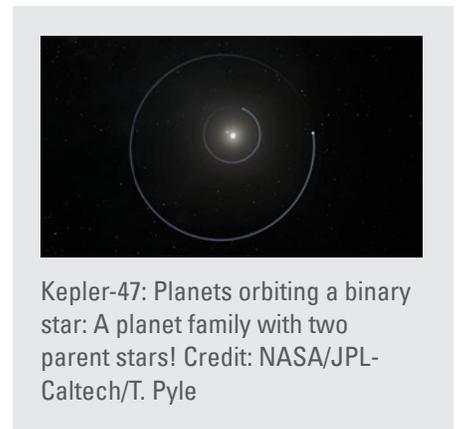
All of these planet families orbit closer to their parent star than Venus orbits our Sun.

Only the planet orbits are shown in this video. The central parent star is not shown. The planet sizes are exaggerated to make them easier to see. The video is also available here: <http://astrosociety.org/KeplerMultiPlanet.mp4>



To see more animations, visit:

<http://kepler.nasa.gov/multimedia/animations/scienceconcepts/>



Kepler-47: Planets orbiting a binary star: A planet family with two parent stars! Credit: NASA/JPL-Caltech/T. Pyle

## ACTIVITY: PLANET FAMILIES — BUILD A SOLAR SYSTEM

Time: 15 minutes to as long as you want

Age: 8 and up

Use an interactive computer simulator to try to build the perfect family of planets orbiting a star. See how different planets react with one another, and see how some planets are important in keeping the family stable.

To use the simulator, visit:

<http://www.alienearths.org/online/starandplanetformation/planetfamilies.php>

The simulator requires your computer to have [Adobe Flash](#) installed.



## Do It Yourself Planet Hunting

Explore one of the great frontiers of science: the search for other worlds and other life. Try your hand at these free citizen science projects:

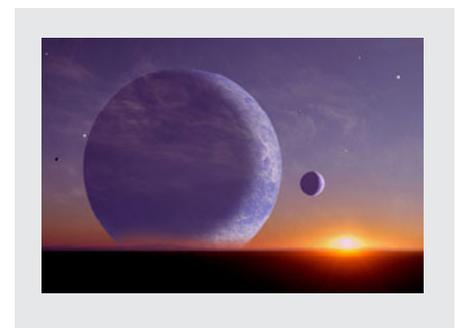
**DIY Planet Search:** Using a telescope that you control online, you can take your very own images of distant Suns known to have orbiting planets. Detect the tell-tale dip as a planet passes in front of your target star. Almost every night you can get new images of one of dozens of exoplanet targets — then analyze and share your data with the DIY Planet Search community! <http://www.cfa.harvard.edu/smgphp/otherworlds/OE/>

**Zooniverse Planet Hunters:** Participants in Planet Hunters look at changes in star brightness using data collected by NASA's Kepler spacecraft. The Kepler team developed computer programs to sift through light curve data because it is not possible for them to visually inspect every light curve. Planet Hunters are betting that there will be a number of surprises in the data that the computer algorithms will miss; that there will be planets which can only be found via the remarkable human ability for pattern recognition. Planet Hunters is an online experiment that taps into the power of human pattern recognition. Participants are partners with our science team. If you are the first to flag a pattern that is later determined to be a planet, you will get credit on the science paper. <http://www.planethunters.org/>

### Find more NASA Activities

Looking for more Earth and Space Science formal and informal education activities?

Try out NASA's digital collection of resources at NASA Wavelength: <http://nasawavelength.org>



## CONNECT TO NASA SCIENCE

### How do we know?

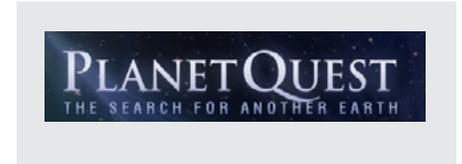
The search for planet families beyond our own is not an easy task. Find out how it is done:

<http://planetquest.jpl.nasa.gov/page/methods>

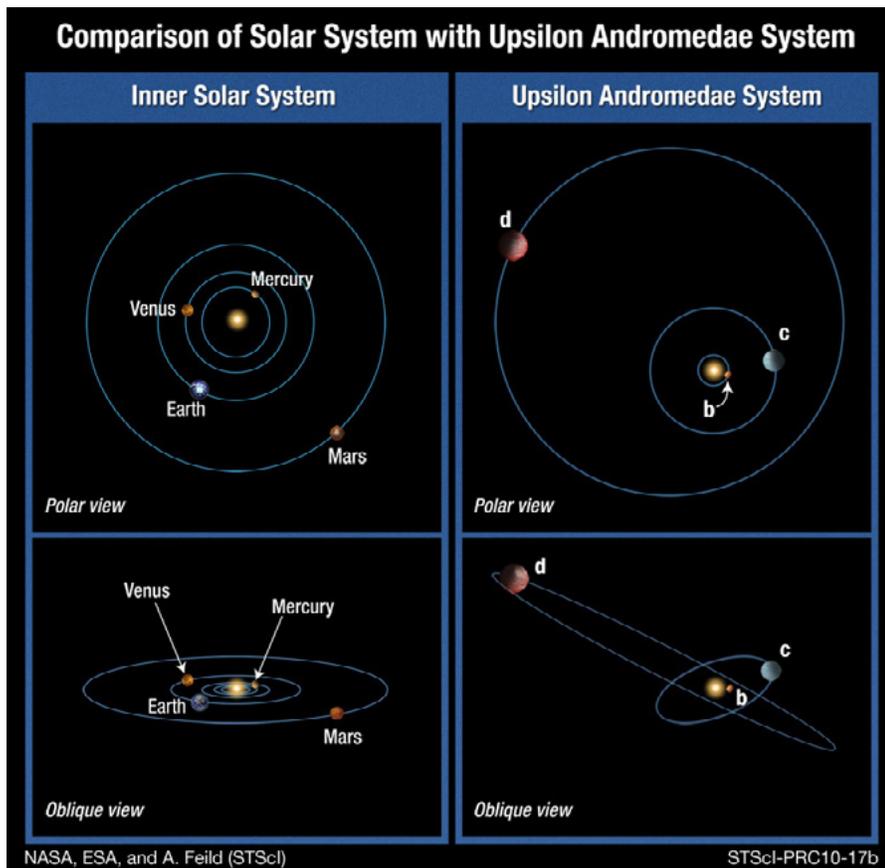
One of the focus areas for science discoveries in NASA Astrophysics is the discovery of planets outside of our Solar System.

Here is an overview of the current state of exoplanet research at NASA:

<http://science.nasa.gov/astrophysics/focus-areas/exoplanet-exploration/>



## Upsilon Andromedae: A Surprising Family of Planets Out of Whack



You may know some strange families, but Upsilon Andromedae's family is completely out of whack. It is one of the oddest planet families known

to scientists and hints to a disturbed past.

See how Upsilon Andromedae's family compares with our Sun's family of planets:

<http://hubblesite.org/newscenter/archive/releases/2010/17/>

For the latest news from Hubble, visit:  
<http://hubblesite.org/newscenter/>

## A planet family with two parents plus an aunt and uncle

PH1 is the name given to a planet family where the planet orbits a two-parent binary star. But that's not all. This planet has aunt and uncle stars that form another binary pair circling around the planet's parent stars. This planet has a lot of relatives around. Read more:

<http://kepler.nasa.gov/news/nasakeplernews/index.cfm?FuseAction=ShowNews&NewsID=233>

This planet family was discovered by volunteers with the Zooniverse Planet Hunters citizen science project. Learn how to become a member of Planet Hunters:

<http://www.planethunters.org/>

For the latest news from the Kepler Mission, visit:  
<http://kepler.nasa.gov/news/nasakeplernews/>

## Not all Planet Families are Stable

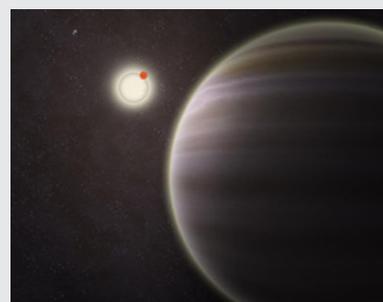
Unlike the relatively stable family of planets in our own Solar System, the Spitzer Space Telescope finds evidence that some families of planets are so unstable, they may self-destruct.

<http://www.spitzer.caltech.edu/news/1182-ssc2010-07-Pulverized-Planet-Dust-May-Lie-Around-Double-Stars>

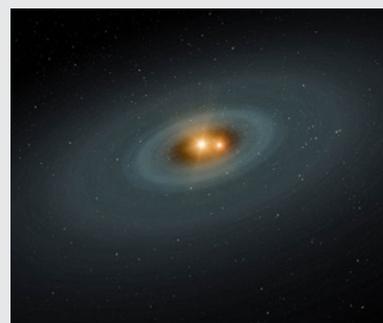
For an entertaining illustrated exploration of this unstable family, watch the Robot Astronomy Talk Show, "Destroyer of Worlds" here:

<http://www.spitzer.caltech.edu/video-audio/1359-iraastro022-Robot-Astronomy-Talk-Show-Destroyer-of-Worlds>

For the latest news from the Spitzer mission, visit:  
<http://www.spitzer.caltech.edu/news>



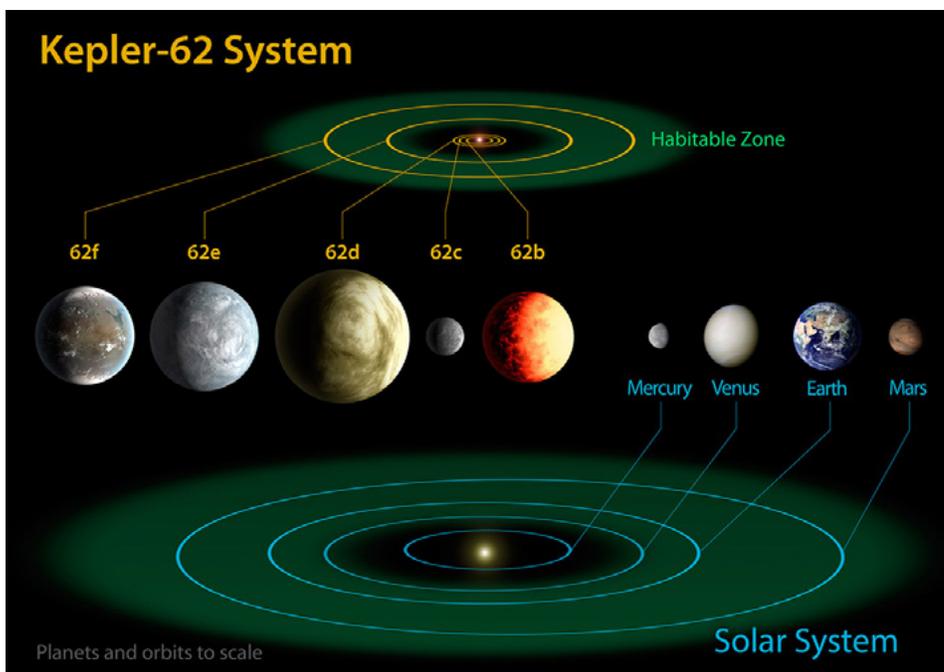
Artist's concept of PH1. Credit: Haven Giguere/Yale



This artist's concept illustrates a tight pair of stars and a surrounding disk of dust — most likely the shattered remains of planetary smashups. Credit: NASA/JPL-Caltech/R. Hurt (SSC)

## Evidence of Planet Families with Possible Earth-like Sibling

The Kepler Mission continues to make great strides in finding unique planet families — even families more like our own. Recent discoveries include families with planets less than twice the mass of Earth orbiting in the habitable zones of their parent stars.



The five planets of the Kepler-62 family (left side) compared to the four rocky planets of our Solar System (right side). Planets 62e and 62f are in the habitable zone where liquid water could exist. Image credit: NASA Ames/JPL-Caltech

Read more:

[http://www.nasa.gov/mission\\_pages/kepler/news/kepler-62-kepler-69.html](http://www.nasa.gov/mission_pages/kepler/news/kepler-62-kepler-69.html)

For an entertaining description of the habitable zone, watch the M51 & Gizmo: Half-Baked Plan animated video here:

<http://www.spitzer.caltech.edu/video-audio/229-irastroSD013-M51-Gizmo-Half-Baked-Plan>

For the latest news from the Kepler Mission, visit:  
<http://kepler.nasa.gov/news/nasakeplernews/>

## ACKNOWLEDGEMENTS

The Universe Discovery Guides are a collaborative effort between members of the NASA Astrophysics education and public outreach (E/PO) community and the NASA Astrophysics Science Education and Public Outreach Forum. We also gratefully acknowledge the informal educators from the Astronomy from the Ground Up (AFGU) and the Sky Rangers communities who field-tested the guides.

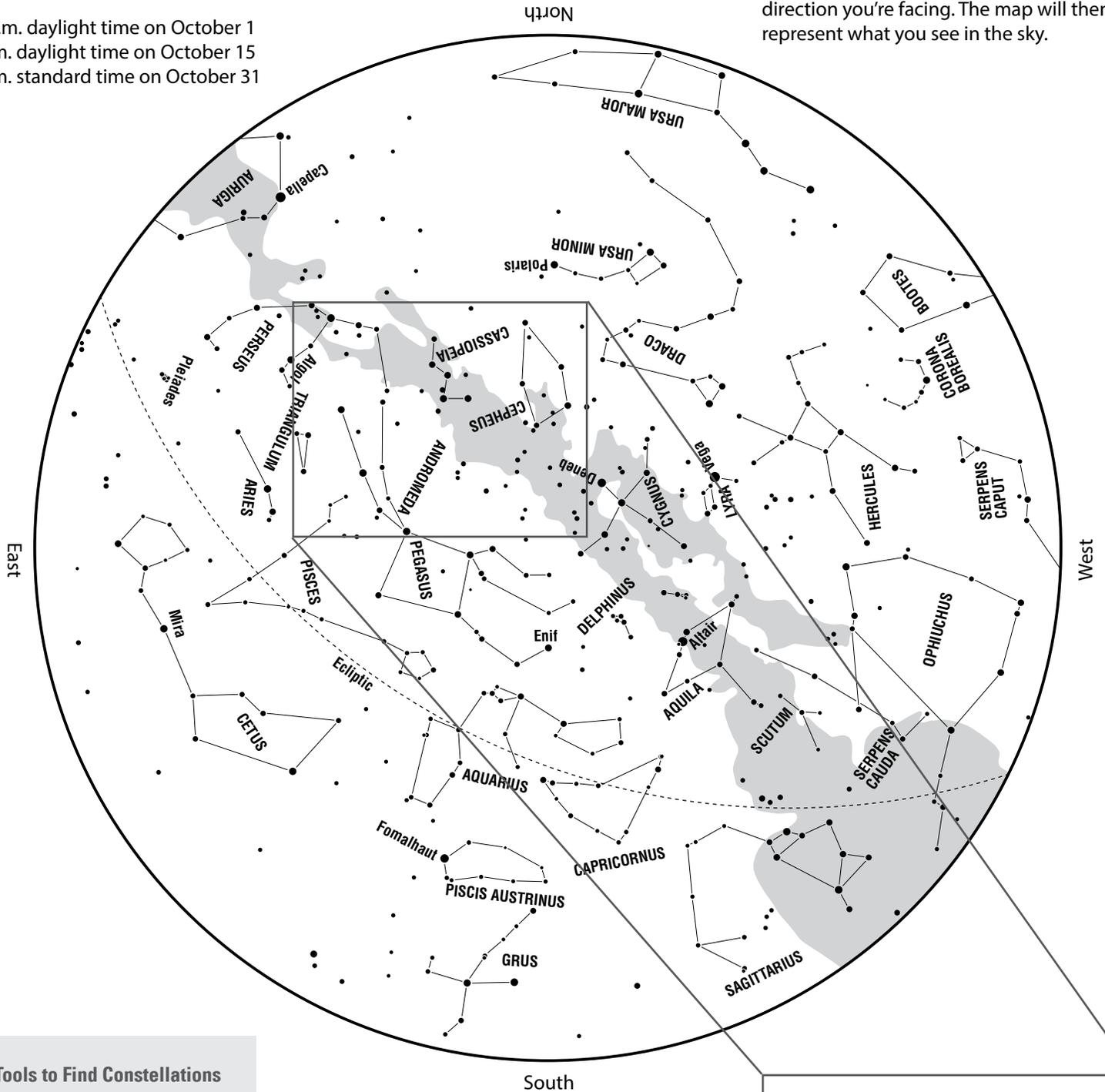
Contributing NASA Astrophysics E/PO programs include: Afterschool Universe, Alien Earths, Astronomy Picture of the Day (APOD), the Chandra X-ray Observatory, the Cosmic Background Explorer (COBE), Cosmic Questions, the Euclid mission, Exoplanet Exploration, the Fermi Gamma-ray Space Telescope, the Galaxy Evolution Explorer (GALEX), the Herschel Space Observatory, the High Energy Astrophysics Science Archive Research Center (HEASARC), the Hubble Space Telescope, Imagine the Universe, the Infrared Processing and Analysis Center (IPAC), the James Webb Space Telescope, the Kepler Mission, the Milky Way Project, the Night Sky Network (NSN), the Nuclear Spectroscopic Telescope Array (Nu-STAR), Observing with NASA (OwN), Other Worlds, the Planck mission, PlanetQuest, Planet Hunters, the Spitzer Space Telescope, StarChild, the Stratospheric Observatory for Infrared Astronomy (SOFIA), the Swift mission, the Two Micron All-Sky Survey (2MASS), the Wide-Field Infrared Survey Explorer (WISE), the Wilkinson Microwave Anisotropy Probe (WMAP), the X-ray Multi-Mirror Mission (XMM-Newton), and Zooniverse.

The Astrophysics Forum is supported by NASA's Science Mission Directorate under Cooperative Agreement NNX09AQ11A to the Space Telescope Science Institute, Astronomical Society of the Pacific, Adler Planetarium and Astronomy Museum, and Johns Hopkins University.

The all-sky map represents the night sky as seen from approximately 35° north latitude at the following times:

- 10 p.m. daylight time on October 1
- 9 p.m. daylight time on October 15
- 7 p.m. standard time on October 31

To locate stars in the sky, hold the map above your head and orient it so that one of the four direction labels matches the direction you're facing. The map will then represent what you see in the sky.



### Tools to Find Constellations

#### For mobile device users:

Search your app store for “planetarium” or “sky map” to find free or low-cost apps. These help you more easily locate constellations.

[View a video on how to read a star map.](#)

### October Sky Feature: Upsilon Andromedae

[Jump to Sky Feature to find out about Upsilon Andromedae](#)

