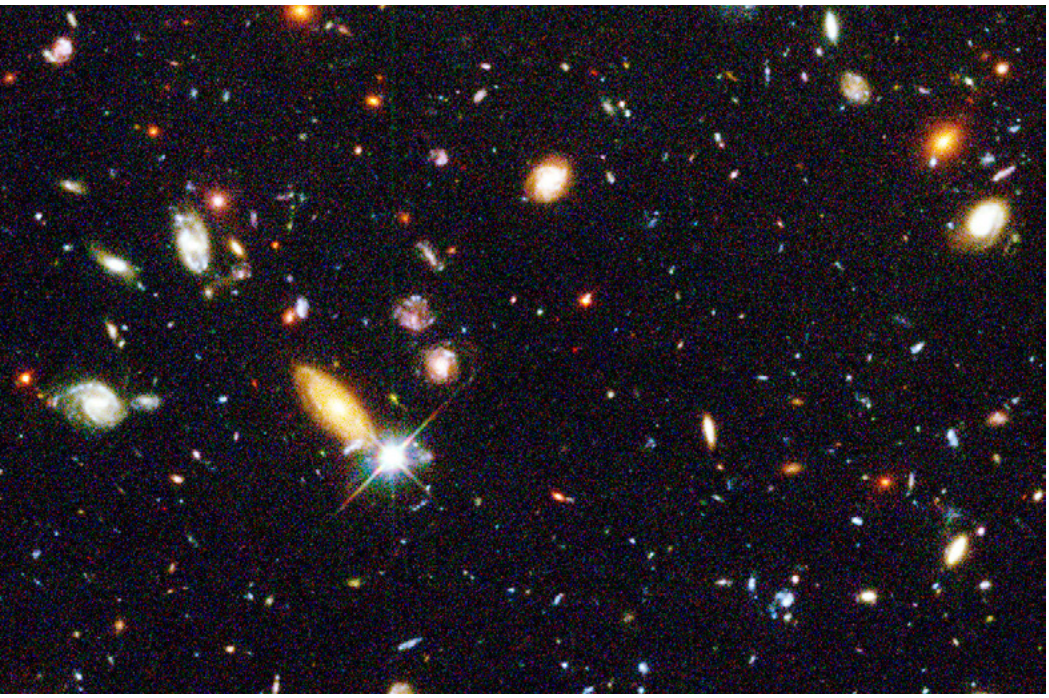
National Aeronautics and
Space Administration

UNIVERSE DISCOVERY GUIDES

May

A FAMILY SCRAPBOOK OF THE UNIVERSE



Hubble Deep Field: The first portrait of distant galaxies from the early universe. Hubble Space Telescope. Credit: Robert Williams and the Hubble Deep Field Team (STScI) and NASA.

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

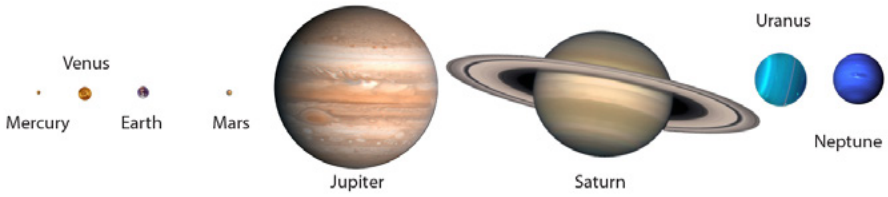
A SCRAPBOOK OF THE SOLAR SYSTEM, GALAXY, UNIVERSE

How is a portrait of distant galaxies like a family scrapbook?

Have you paged through a scrapbook to see photographs of your family that show how they looked a few days ago to many years ago? A scrapbook is like a time machine that takes you into the past.

When NASA astronomers take photographs with telescopes, it is like using a time machine too. For most objects out in space, the light we see today has been traveling from a few minutes to millions or even billions of years to reach us. The farther we look, the farther into the past we see. **With that in mind, we'll put together a scrapbook with portraits of universe's family.**

Solar System, Galaxy, Universe: How far back in time?



Planets of the Solar Systems (distances between planets are not to scale). Compiled from NASA images.

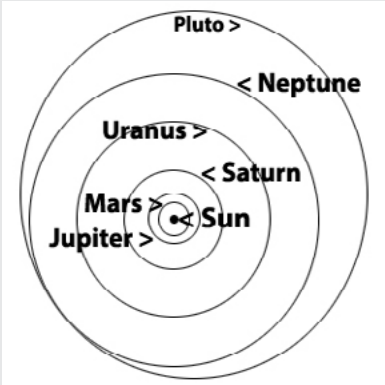
Let's start with our closest relatives.

Our **Solar System** consists of our star, the Sun, and its orbiting planets, along with numerous moons, dwarf planets, asteroids, comet material, rocks, and dust. Sunlight reflecting off the most distant planet, Neptune, only takes about 4 hours to reach us here on Earth. So for our scrapbook, the photographs we take now of planets in our Solar System would show them as they looked a few minutes to a few hours ago.

Our Sun is just one star among the hundreds of billions of stars in our **Milky Way Galaxy**. To understand the size of the Galaxy compared to the Solar System, let's shrink the Sun down to smaller than a grain of sand. Imagine our Solar System to be small enough to fit onto the palm of your hand. The diagram (top right) is about the right size.

On that scale, the **Milky Way Galaxy**, with its 200–400 billion stars, would span North America.

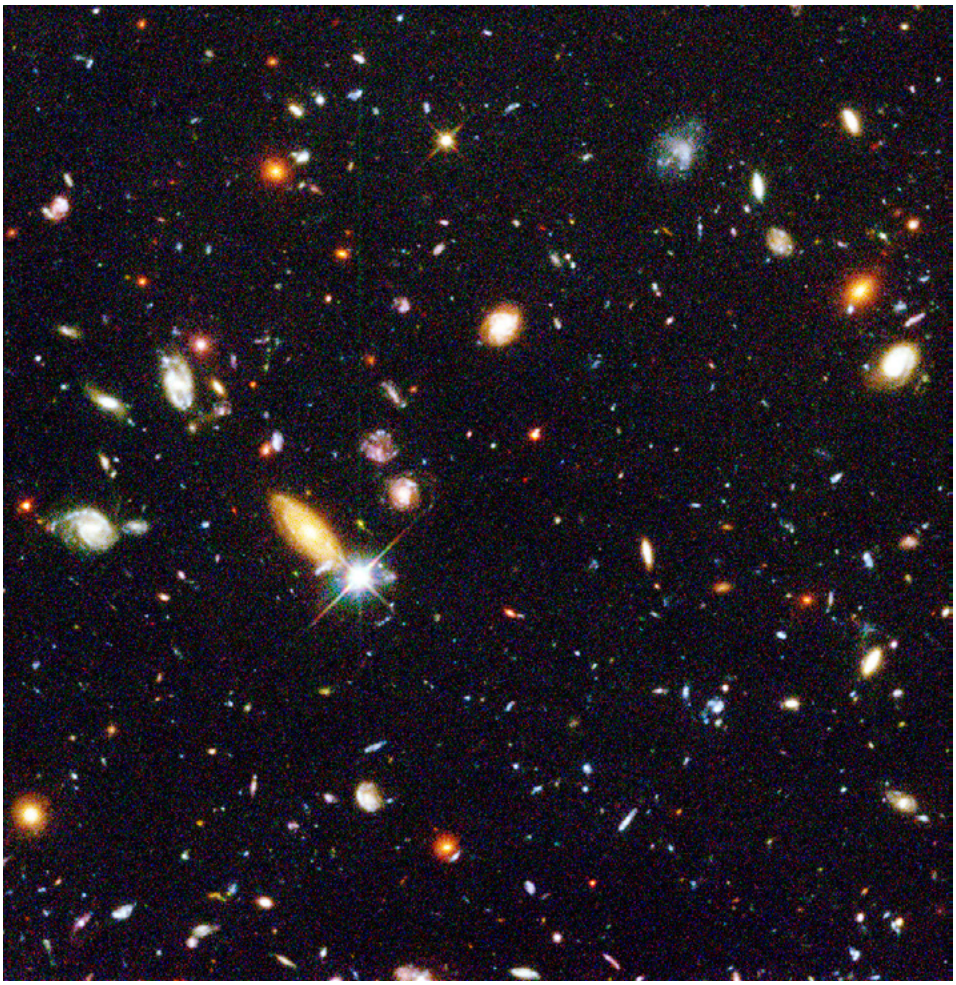
It takes light from a star on one side of the Milky Way 100,000 years to reach a star on the other side. So for our scrapbook, portraits of stars in our Galaxy show them as they were a few years to thousands of years ago.



2 inches

If we shrink the Solar System to fit in the palm of your hand, on that scale, our Milky Way Galaxy would span North America. Credit: NASA/ASP

The **Universe** is all of the galaxies — billions of them! NASA's telescopes allow us to study galaxies beyond our own Milky Way and explore the most distant reaches of the observable universe. The image below was the first one taken by the Hubble Space Telescope to reveal the early universe. Light from the most distant observable galaxies in this image has been traveling over 10 billion years to reach us. In our universe's family scrapbook, this portrait shows the galaxies as they looked millions to billions of years ago. Scientists have come to discover that, like people, galaxies change in appearance over time. Just as babies look much different than grandparents, infant galaxies in the early Universe look much different than the adult galaxies of today.



Nearly everything in this image is a galaxy, each galaxy comprised of millions to billions of stars. Even the smallest, faintest, smudges are individual galaxies very far away from us. Credit: Robert Williams and the Hubble Deep Field Team (STScI) and NASA.

SKY FEATURE: HUBBLE DEEP FIELD

How to Find it

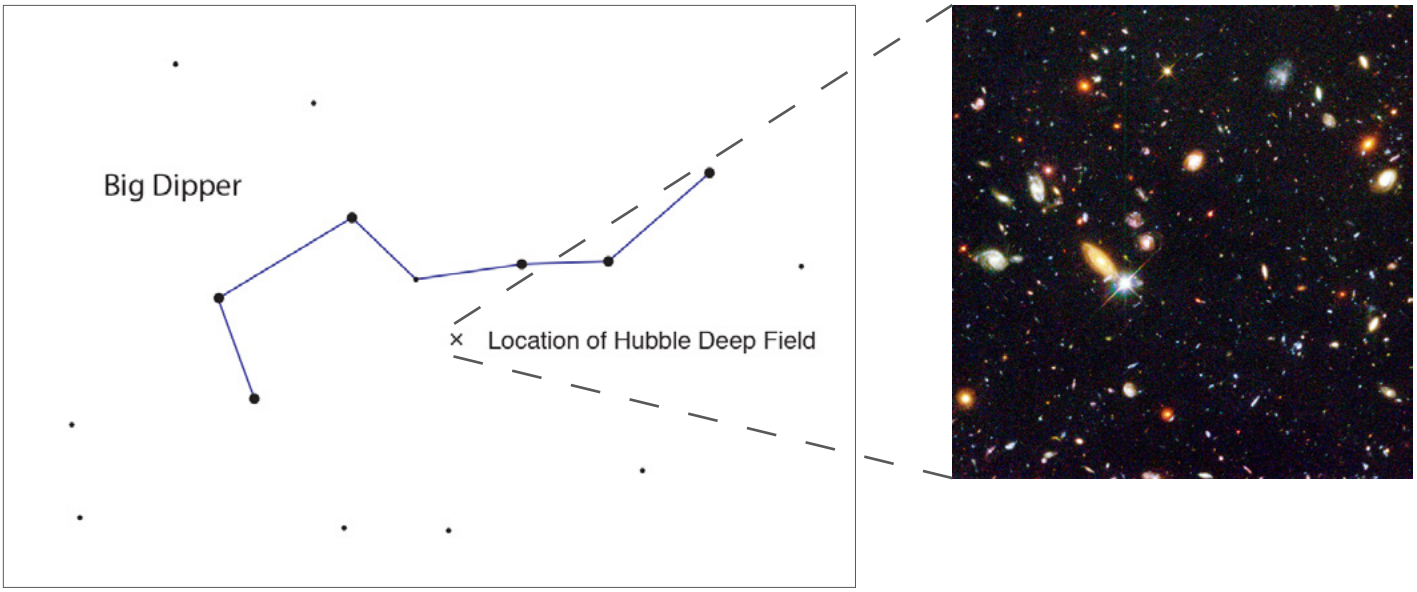
Distance: up to 10 billion light-years

To view: just your eyes

Click here to jump to the full-sky May Star Map.

If you can find the Big Dipper, you can find the area of the sky where the Hubble Space Telescope took this image.

In May during the early evening, the Big Dipper is high in the northern part of the sky and appears to be upside down.



An adult can get a needle or a pin and a 3x5 card – any card-like material will do. Poke a hole through the card with the needle.

Hold the card at arm's length up toward the sky. Close one eye and look through the hole. That is how much of the sky the Hubble Space Telescope was observing for about ten days straight to take this image.

This patch of the sky was chosen because it seemed to be empty. Astronomers were not certain that they would see anything at all. In this tiny area of the sky, Hubble revealed over 1,500 galaxies – of many different ages. Quite a family portrait!

TRY THIS!

Telescopes as Time Machines

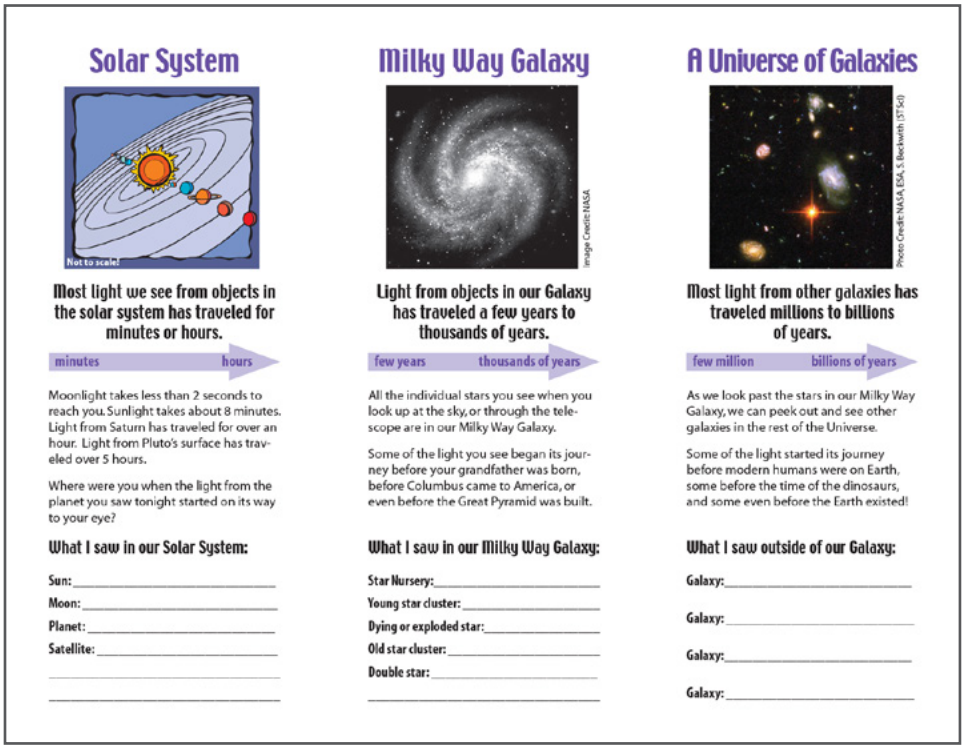
If you'd like to look through a time machine, contact your local amateur astronomy club to find out about their next public observing event. You may be able to look through the club's telescopes at planets in our Solar System, stars in our own Milky Way Galaxy, and other galaxies out in the rest of the Universe.

NASA's Night Sky Network is a community of hundreds of amateur astronomy clubs dedicated to sharing the universe with people like you in their communities.

http://nightskynetwork.org

Be sure to take along this Passport as you travel back in time! Then plan for a return visit: it might take more than one trip to see all of these sky features.

http://nightsky.jpl.nasa.gov/docs/10passportSM.pdf



Solar System

Not to scale!

Most light we see from objects in the solar system has traveled for minutes or hours.

minutes — hours

Moonlight takes less than 2 seconds to reach you. Sunlight takes about 8 minutes. Light from Saturn has traveled for over an hour. Light from Pluto's surface has traveled over 5 hours.

Where were you when the light from the planet you saw tonight started on its way to your eye?

What I saw in our Solar System:

Sun: _____

Moon: _____

Planet: _____

Satellite: _____

_____

_____

Milky Way Galaxy

Image Credit: NASA

Light from objects in our Galaxy has traveled a few years to thousands of years.

few years — thousands of years

All the individual stars you see when you look up at the sky, or through the telescope are in our Milky Way Galaxy.

Some of the light you see began its journey before your grandfather was born, before Columbus came to America, or even before the Great Pyramid was built.

What I saw in our Milky Way Galaxy:

Star Nursery: _____

Young star cluster: _____

Dying or exploded star: _____

Old star cluster: _____

Double star: _____

_____

A Universe of Galaxies

Photo Credit: NASA, ESA, S. Beckwith (STScI)

Most light from other galaxies has traveled millions to billions of years.

few million — billions of years

As we look past the stars in our Milky Way Galaxy, we can peek out and see other galaxies in the rest of the Universe.

Some of the light started its journey before modern humans were on Earth, some before the time of the dinosaurs, and some even before the Earth existed!

What I saw outside of our Galaxy:

Galaxy: _____

Galaxy: _____

Galaxy: _____

Galaxy: _____

Hubble Deep Field Academy

Explore online real astronomical data to uncover secrets of the universe, hidden in the Hubble Deep Field image.

http://amazing-space.stsci.edu/resources/explorations/hdf/

For more Hubble education and public outreach activities from the Space Telescope Science Institute, see here:

http://amazing-space.stsci.edu/

http://amazing-space.stsci.edu

Size & Scale of the Universe

Many people are not clear about the difference between our Solar System, our Galaxy, and the Universe. In addition, the sizes and distances are far beyond our everyday experience.

If you are involved in a classroom setting, use this exploration to help clarify the difference along with the sizes and distances by examining the Universe at different realms, from Earth to galaxy superclusters within the universe.

This exercise, along with other Wide-Field Infrared Survey Explorer (WISE) classroom activities can be found here:

http://wise.ssl.berkeley.edu/education_class.html

http://wise.ssl.berkeley.edu

ACTIVITY: COSMIC SURVEY

Time: One hour
Age: 11 and up

Session 2: Cosmic Survey from the *Afterschool Universe*

Download the materials for “Session 2 — Cosmic Survey” from this web page: http://universe.nasa.gov/au/curriculum.html

Questions on how big, how far, and how old objects are in the Universe allow discussions about where in space the objects are located and when they formed. Participants work in teams to physically manipulate paper images of objects on Earth and in space, allowing them to develop and present their own mental models to address these questions.

This activity was adapted by the Afterschool Universe program, with permission from the Harvard-Smithsonian Center for Astrophysics, from the Cosmic Questions Educator’s Guide.

These activities help develop the skills needed to address sizes, distances, and ages by looking at objects in each context and applying limited knowledge to classify them.

For more education and public outreach activities from the Afterschool Universe program, visit http://universe.nasa.gov/au/

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

NASA WAVELENGTH
A Full Spectrum of NASA Resources for Earth and Space Science Education

http://nasawavelength.org

CONNECT TO NASA SCIENCE

How do we know?

What do scientists use to measure distances to the galaxies? NASA's StarChild series sees red:
http://starchild.gsfc.nasa.gov/docs/StarChild/questions/question39.html

Explore through space and time to answer the question: How far is it?
http://www.cfa.harvard.edu/seuforum/howfar/index.html

Even Earlier Scrapbook Photos

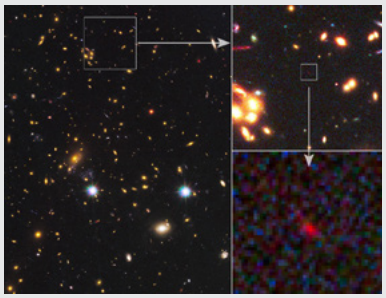
A new and improved Deep Field: The Hubble Space Telescope combined 10 years of Hubble data to create the farthest view yet of the Universe, this time in a similarly small patch of sky in the southern hemisphere. Explore the Extreme Deep Field here:
http://hubblesite.org/newscenter/archive/releases/2012/37/

Watch this NASA video for a trip into the past with the Extreme Deep Field:
http://www.youtube.com/watch?v=gu_VhzhlqGw

NASA SCIENCE | ASTROPHYSICS

http://science.nasa.gov

Combining images from the Hubble Space Telescope and the Spitzer Space Telescope has revealed some of the most distant galaxies ever imaged. Light from the young galaxy in this image first shone about 13.2 billion years ago.
http://www.spitzer.caltech.edu/news/1450-ssc2012-12-NASA-Telescopes-Spy-Ultra-Distant-Galaxy



Credit: NASA/ESA/STScI/W. Zheng (JHU), and the CLASH team

Light from this infant galaxy took 13.3 billion years to reach us here on Earth. The light was first emitted when the Universe was only 420 million years old: just 3% of the Universe's present age of 13.8 billion years!
http://hubblesite.org/newscenter/archive/releases/2012/36/

How old are you now?	3% of your current age
10 years	3-1/2 months
25 years	9 months
40 years	14 months
65 years	2 years
80 years	2-1/2 years
100 years	3 years

Credit: NASA, ESA, M. Postman and D. Coe (STScI), and the CLASH Team

Do you have a photo of yourself from back then? Did you look different than you do today? Galaxies, too, looked different in their infancy.

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

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

Coming Next: Photographs of our Universe at its Birth

The James Webb Space Telescope is under construction and scheduled for launch later this decade. It will peer even farther than previous telescopes. Two of the prime science goals of the James Webb Space Telescope are:

- To take images of the very first light in the universe:
  http://www.jwst.nasa.gov/firstlight.html
- To take portraits of how galaxies assembled in the early universe:
  http://www.jwst.nasa.gov/galaxies.html

To learn more about the James Webb Space Telescope, visit:
http://webbtelescope.org/webb_telescope/

Full-scale model of the James Webb Telescope on display in Baltimore. NASA Webb Telescope.

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.

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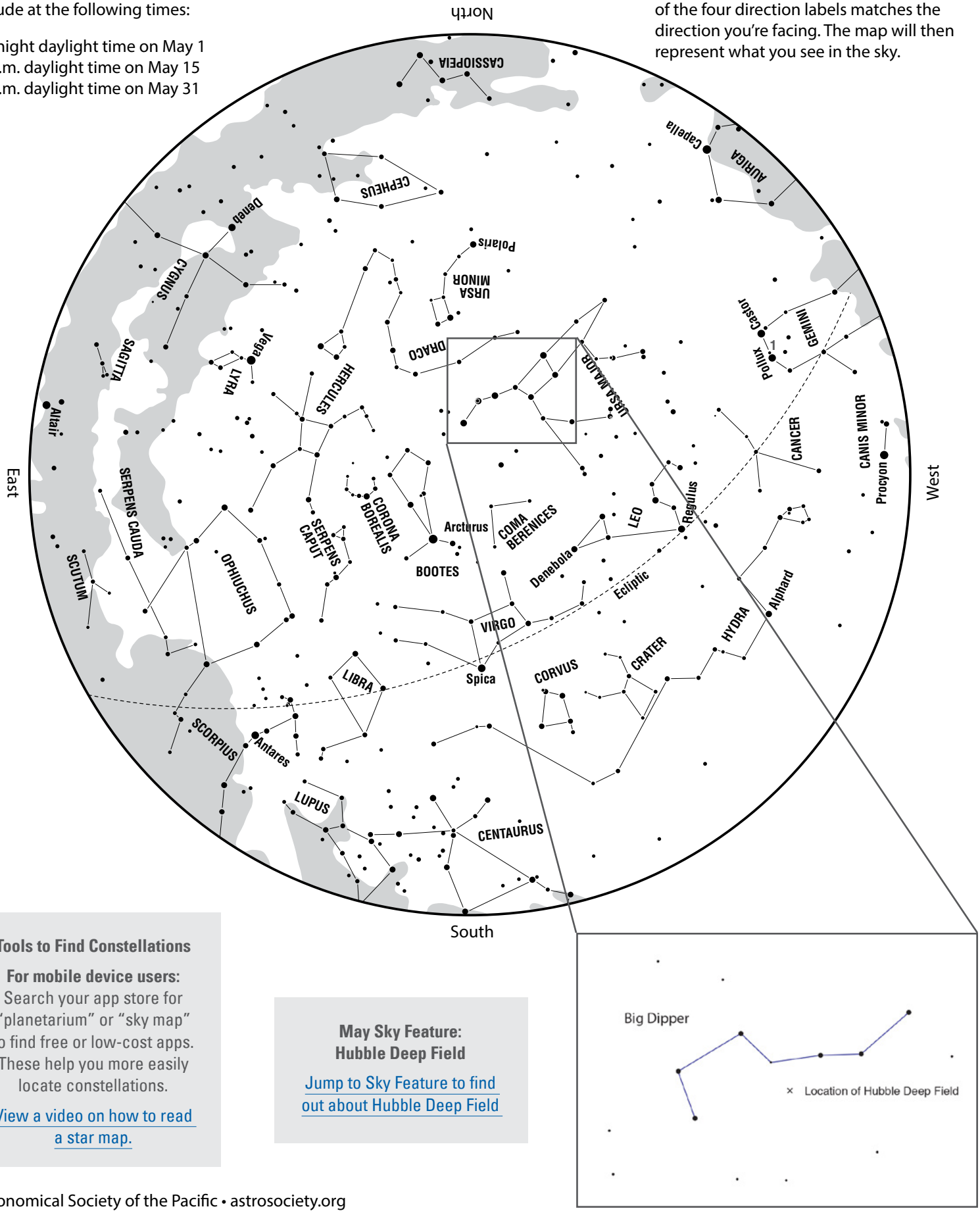
APPENDIX: MAY STAR MAP

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

midnight daylight time on May 1
11 p.m. daylight time on May 15
10 p.m. daylight time on May 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.

May Sky Feature: Hubble Deep Field

Jump to Sky Feature to find out about Hubble Deep Field