National Aeronautics and Space Administration

OBSERVING CARDS

INDEX

Index

National Aeronautics and Space Administration

OBSERVING CARDS

There are many resources created for your visitors at your outreach events. These cards, however, are created as a reference for *you*, the host.

Use them if you:

- are new to public outreach and aren't sure what to say
- are looking for a new way to explain some of those same objects you've been talking about for years.

Give your visitors a new perspective on the wonders of the sky. ***See what happens!***

Cards for: double stars, galaxies, globular clusters, moons, open clusters, planetary nebulae, planets, red giant stars, stars with planets, star nurseries, and supernova remnants.

Index

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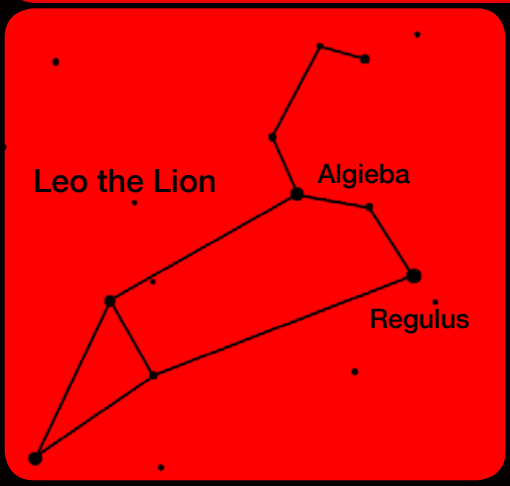
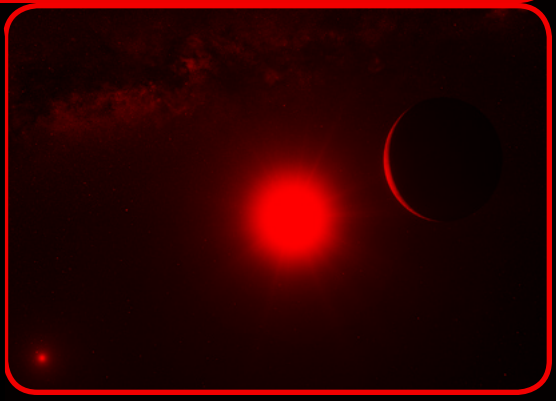
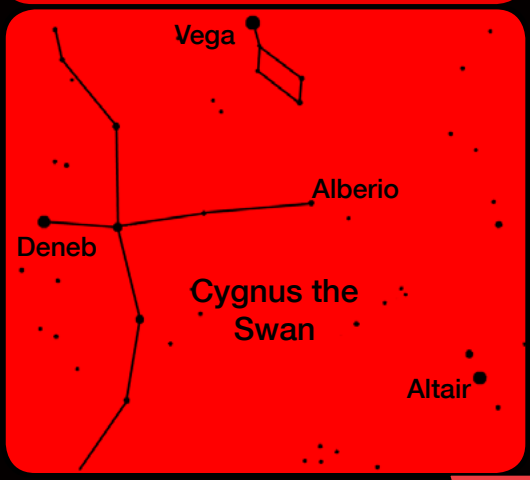
DOUBLE STARS

One of the brightest in Leo's mane, Algieba is a double-star system with a gas giant planet orbiting the larger star. Below is an artist's idea of a system like this.

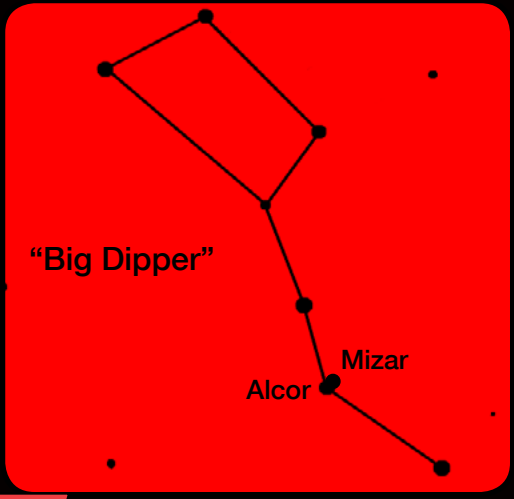




Prominent in the summer sky, Cygnus's Alberio is a blue and a yellow double star system. The yellow star is actually another double, but too close together to see.



Mizar and Alcor, double stars in the Big Dipper, can be seen by those with keen eyesight.
There is an Arabic saying, "He can see Alcor but not the full Moon." It's similar to the contemporary saying, "He can't see the forest for the trees."



Index

DOUBLE STARS

EXAMPLES OF DOUBLE STARS

Mizar and Alcor in the Big Dipper, visible all year: Do you think you have perfect vision? Recent testing has shown that the ability to see both of these stars is almost identical to the modern tests for 20/20 vision. Even the best vision can't see that there are actually 6 stars! For that we need a telescope.

Albireo in Cygnus, Summer: This swan has captured some dazzling jewels in its beak.

Algieba (gamma Leo), Spring: Both of these large stars are nearing the end of their lives. It doesn't bode well for the planet orbiting the larger star.

Viewing Double Stars is Twice the Fun!

It's common for stars to come in pairs but they're not necessarily identical twins. Double stars of different sizes and colors beautifully illustrate the variety of our stellar neighbors.

Planets have been found around double stars. Imagine living on a planet orbiting a double star. You could have 2 shadows! Would it ever get dark?

A difference in color means a difference in temperature. Blue stars are hotter than our Sun, red stars cooler. Would a planet need to orbit nearer or farther away from a hot blue star to stay warm but not hot?

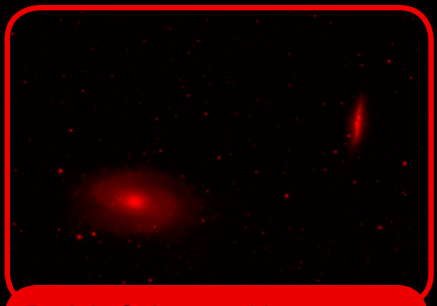
If Earth had formed around a cooler red star, our eyes may have developed differently because cool stars emit more infrared light than our Sun does. Maybe we could see infrared light instead of the colors of the rainbow. It would be like walking around with night-vision glasses!

Why limit it at two? Stars come in triplets and even larger configurations. Polaris, the North Star is actually a 3-star system.

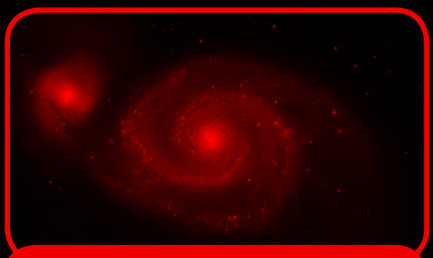
Index

National Aeronautics and
Space Administration

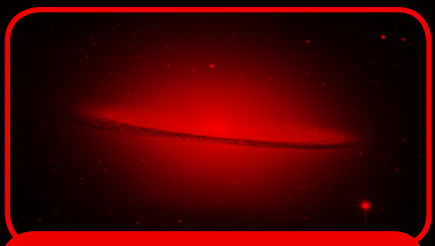
GALAXY



Bode's Galaxy and its neighbor are part of the same galaxy cluster.



The Whirpool Galaxy shows massive spiral arms.



Seeing the Sombrero edge-on helps new observers understand what they're seeing when looking up at our own Milky Way disk.

The nearest large galaxy, Andromeda, can even be seen without a telescope.

We are within the disk of the Milky Way. The gas and stars provide a rich view in dark skies.

Index

GALAXY

EXAMPLES OF GALAXIES

Andromeda (M31), Autumn: If the Milky Way were the size of a CD, the Andromeda would be the size of a dinner plate. And at that scale, they'd be about 8 feet apart.

Whirlpool (M51), best Winter/Spring: Is actually a pair of interacting galaxies!

Sombrero (M104), Spring: Seen edge-on, this spiral galaxy is also on the edge of a galaxy cluster, though not part of it. Virgo is full of many types of galaxies, including ellipticals.

Bode's Galaxy (M81), best Spring/Summer: This is a great first star-hopping target to find in binoculars or a small telescope. See if newbies can also find the thin starburst galaxy nearby (M82).

Looking up, galaxies are the most distant object we can see.

There are hundreds of billions of galaxies in the Universe. Each galaxy consists of millions to billions of stars. That means there are more stars in the Universe than all the grains of sand on every beach in the world!

If we want to get an idea of what our Milky Way Galaxy might look like from above, we need to look no further than another galaxy. We live in a spiral galaxy, and can see only see the stars in our nearby neighborhood.

We can't see the whole Milky Way because we are in the middle of the disk - just like we can't see our whole town from our porch at night, just the lights nearest us. Do you think any of those nearest stars might include a planet with life on it, looking back at us?

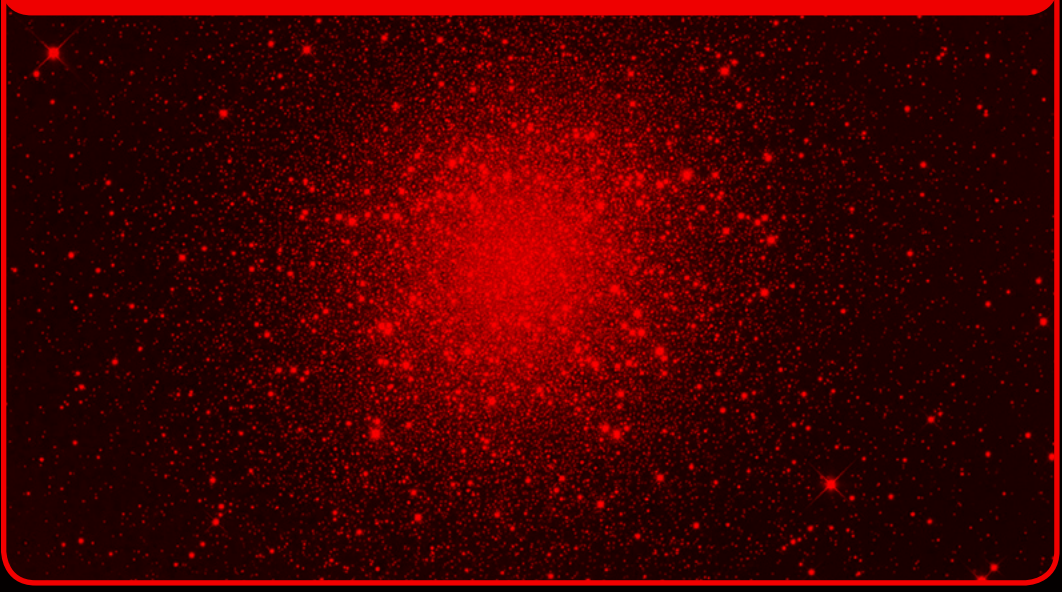
It's estimated that half of all stars might support planets. Beyond all the stars in our own galaxy, look at that galaxy full of stars! Imagine the alien possibilities with all those worlds.

Index

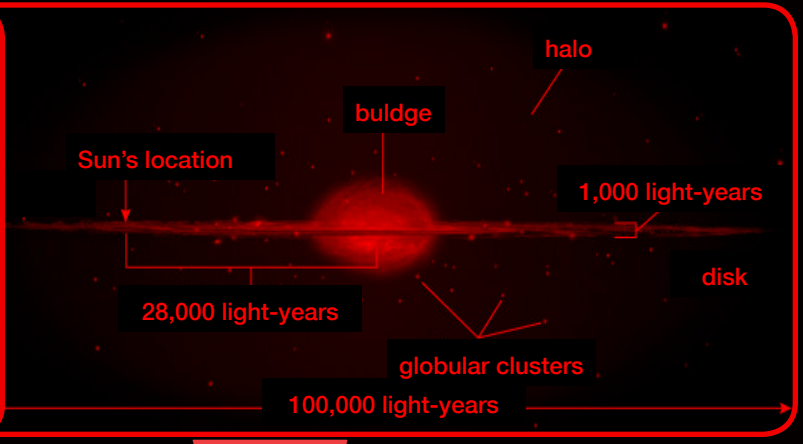
National Aeronautics and Space Administration

GLOBULAR CLUSTER

M13, the Great Hercules Globular is one of the finest you'll observe. In 1974 we sent our first directed message into outer space with the Arecibo Observatory. This radio message about Earth was sent in the direction of this globular cluster. Its journey will take more than 25,000 years. Our aim was a bit off though. By the time it arrives, the cluster will have moved! Anyway, we have discovered very few planets in globular clusters, and have found more promising targets for our next messages.



Globular clusters orbit our Milky Way Galaxy (illustration of a side view here) like tight swarms of bees. They are not typically in the disk of the galaxy, unlike most Milky Way objects that we observe.



Index

GLOBULAR CLUSTERS

EXAMPLES OF GLOBULAR CLUSTERS

Scorpius Cluster (M4), Summer: is relatively small, with only about 10 thousand stars. This is a very easy cluster for new star hoppers to find because it is close to the bright star Antares. Challenge them to find it on their own in binoculars or a small telescope.

Hercules Cluster (M13), Spring: has about 300,000 stars — as many stars as all the hairs on 3 people's heads!

M79 in Lepus, Winter: This is one of the few globular clusters seen in the winter, when we face away from the galactic center.

Small, old, and far away, so what?

Globular clusters are much farther away than anything else we observe, except other galaxies.

The dense group of stars that make up a globular cluster include some of the oldest stars in the Universe. They give us a view of what our future holds.

In a globular cluster, there are many stars packed into a small space. *Imagine* the view from inside a globular cluster.

In the center, it would never get dark. There are so many stars, that even at night it would never get dark. Imagine dozens of brilliant stars for every star you see tonight!

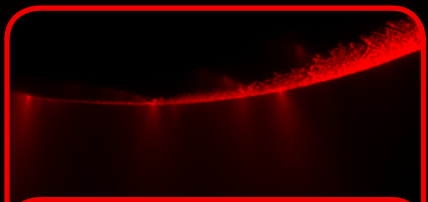
If you were on the edge of the cluster closest to Earth, all of the cluster's stars would be in one half of the sky and the other half would be lit up with the hazy Milky Way.

Could we look back at the Milky Way and see our Sun? No, it would be like trying to pick out your porch light on a map of the US at night!

Index

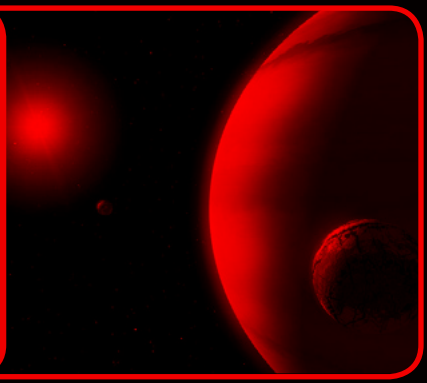
National Aeronautics and Space Administration

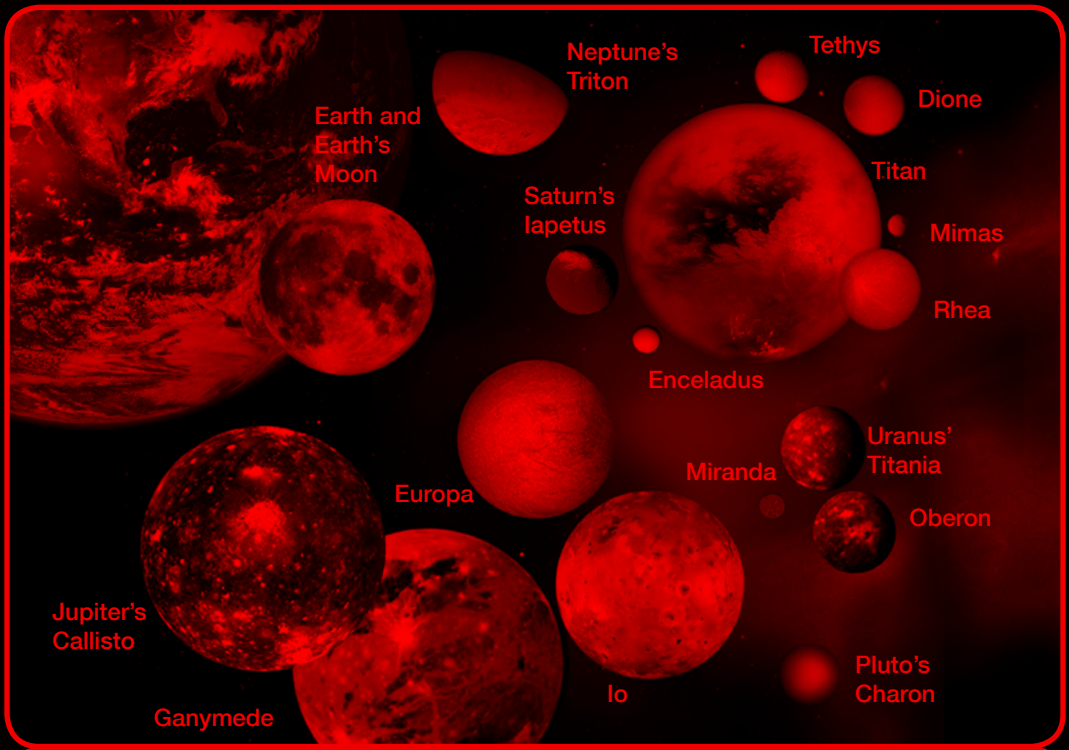
MOONS



Saturn's moon Enceledus is spraying geysers of water from its south pole, as seen in this picture. Some of this water actually rains down on Saturn.

Imagine the possibilities if exoplanets in habitable zones of their parent stars had rocky moons with atmospheres. Here, an artist dreams.





Pictured to scale are photographs of Earth and its Moon; Jupiter's four largest moons; seven of Saturn's moons; Neptune's largest moon Triton; three of Uranus' moons, and Pluto's largest moon, Charon.

Index

MOONS

EXAMPLES OF OUR SOLAR SYSTEM'S MOONS

Earth's Moon is the farthest place that humans have voyaged. That first footprint of Neil Armstrong's is still there and will remain there for millions of years. There's no wind on the Moon to blow it away.

Jupiter's Moons: Galileo discovered four of Jupiter's largest moons. Let's see how many we can observe tonight. These moons are much more active than Earth's Moon, hosting volcanoes (Io), oceans covered in ice (Europa), and a magnetic field (Ganymede).

Saturn's Moons: While Saturn is best known for its rings, it's also home to a plethora of moons big and small, over 50 and counting. Some of these "shepherd moons" orbit within its rings and create gaps in the thin icy disc.

There is no shortage of interesting moons in our Solar System.

Can we see the flag on the Moon through our telescope? No, the smallest feature we can see through most telescopes is about a mile across.

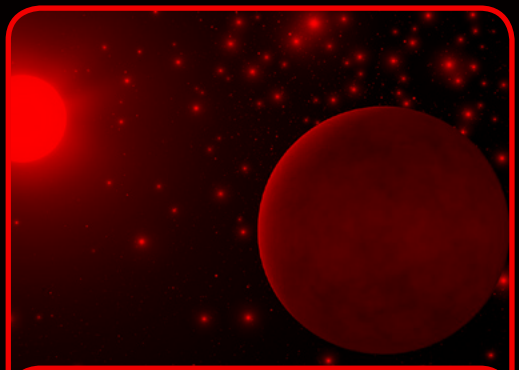
Saturn's moons interest scientists who look at life in extreme environments here on Earth. The giant moon Titan and Earth both have atmospheres mostly made of nitrogen. Liquid water is rare outside of the Earth, but tiny Enceledus is spraying geysers of it into space. That's evidence of an ocean beneath its icy surface. Imagine the different kinds of life that might develop on such strange worlds.

While moons around exoplanets are still very hard to detect, imagine the possibilities if gas giant planets could host habitable moons. See an artist's idea of this world on the other side.

Index

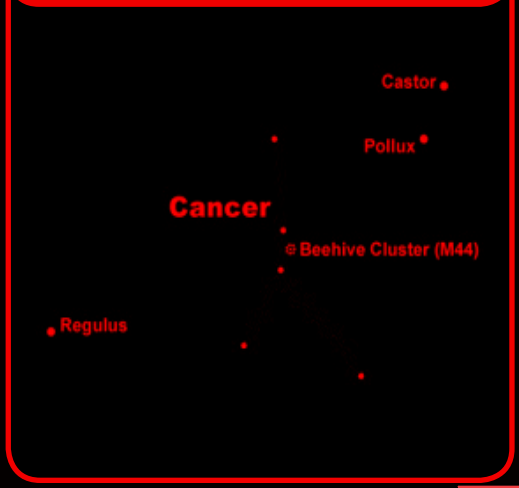
National Aeronautics and Space Administration

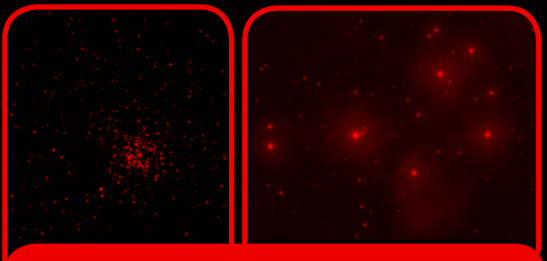
OPEN CLUSTER



From a planet orbiting a star in an open cluster, the night sky would be filled with bright new stars, as seen in the artist's conception above.

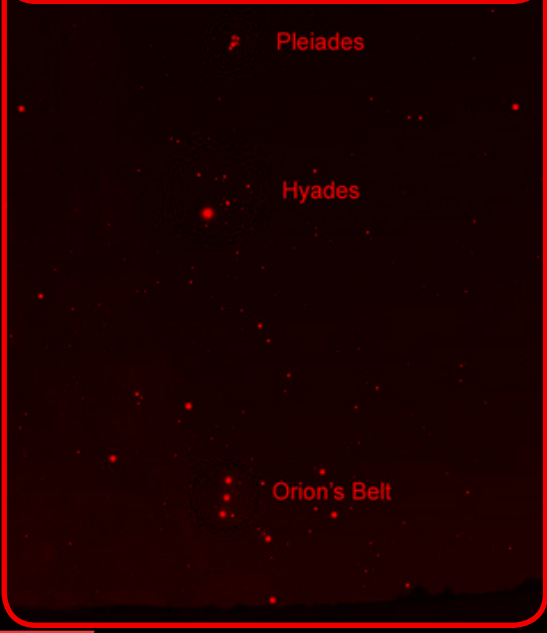
Scientists are finding planets around Sun-like stars in open clusters like the Behive Cluster. We can find the Beehive Cluster about halfway between the two stars, Regulus and Pollux.





Open clusters vary in appearance, as seen in the contrast above between the Wild Duck Cluster (left) and the Pleiades(right), not shown to scale.

Two clusters that are easy to spot in dark skies are the Hyades, or head of Taurus the Bull, and the nearby Pleiades, also known as the seven sisters. Just follow the line of Orion's Belt as seen below.



Index

OPEN CLUSTER

EXAMPLES OF OPEN CLUSTERS

Pleiades (M45) Winter: The Pleiades were born while the dinosaurs were roaming the Earth – about 100 million years ago. This cluster happens to be drifting through a cloud of gas - not the one from which it was born.

Hyades, in Taurus, Winter: This is the closest open cluster to us and makes a large V shape. (Aldeberan is not part of the cluster.)

Wild Duck (M11) in Scutum, Summer/Autumn: One of the richest clusters. Does it look like a flock of ducks in flight to you?

Beehive (M44), Spring: This is an easy first star-hopping target with binoculars. Find it between Pollux and Regulus.

Meet some of our newest neighbors, stars in open clusters.

The newly-formed stars in an open cluster were born from the same cloud of gas and dust. We call it “open” because the haze that surrounded them has blown away and you can see the individual stars.

Open clusters bright, young, and often blue - the teenage sisters of stars. They’ve blown off the rest of their parental dust and hang together. Eventually the stars drift apart, but for now, they travel in a pack through their neighborhood (spiral arm).

While globular clusters and open clusters sound similar, they are very different in number and age. Globular clusters can include hundreds of thousands of very old stars bound in a tight swarm. In roughly the same amount of space, an open cluster may have just 100 or so young stars.

Planets orbiting stars within open clusters likely live very chaotic lives. When our Sun was still in a cluster with its sisters, a planet slammed into Earth, eventually creating our Moon.

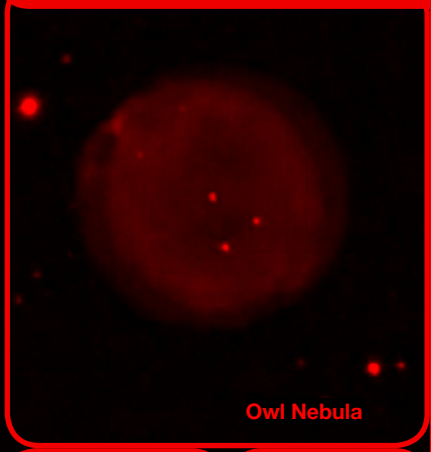
Index

DRAFT VERSION

National Aeronautics and Space Administration

PLANETARY NEBULA

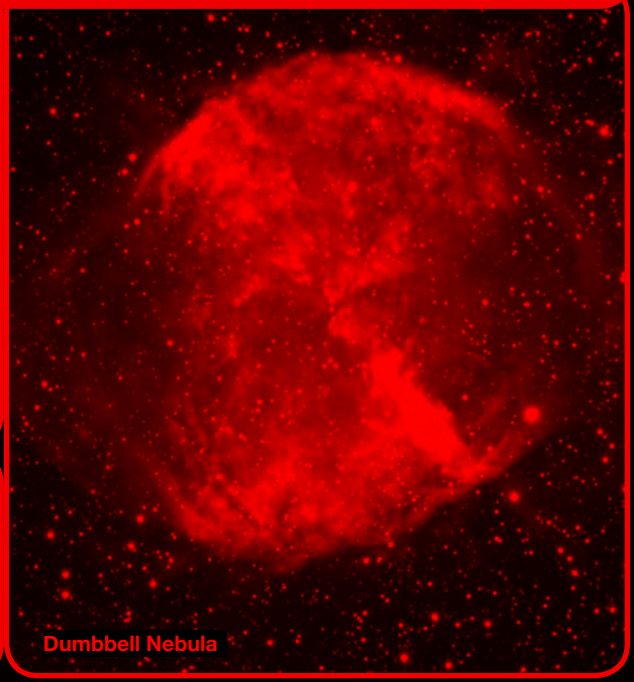
Compare the apparent sizes of the featured planetary nebulae.



Owl Nebula

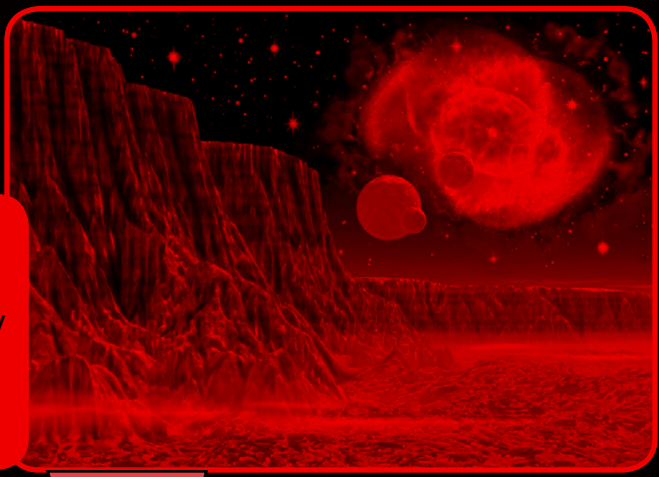
Ring Nebula

Ghost of Jupiter



Dumbbell Nebula

These shells of gas and dust are bombarded with radiation from the central star, causing them to glow.



This is an artist's impression of what it might look like from an imaginary planet orbiting a star going through the planetary nebula phase. The planet's atmosphere has been stripped away, and it is too hot for liquid water.

Index

PLANETARY NEBULA

EXAMPLES OF PLANETARY NEBULAE

Ring Nebula (M57), Summer/Autumn: We see this nebula from its pole. If we could see it from the side, it would likely look more like the Dumbbell.

Dumbbell Nebula (M27), Summer: This large nebula spreads out over more than 4 light-years. That's about the distance between us and our nearest star. It's easy to see how the elements get spread far from the dying star.

Owl Nebula (M97), best viewed in Winter/Spring: This nebula is named for the two dark spots that look like big eyes the center.

Ghost of Jupiter Nebula, Spring: Like many planetary nebulae, this one appears greenish and not quite round. Green is the color humans see best, which is lucky because it is faint.

From Red Giant to White Dwarf in a Few Puffs

The name planetary nebula is a misnomer. It was given to this class of object because they appear small & round and were thought to resemble the then-recently discovered planet Uranus. In fact, planetary nebulae are the swan songs of stars like our Sun after they become red giants. They puff off their outer layers, collapse, and slowly cool off as a white dwarf.

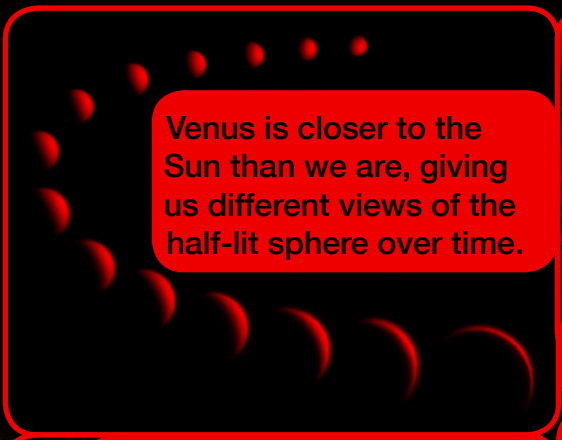
The planetary nebula phase represents a short but important time in the life of stars up to 8 times the mass of our Sun. If we compared that period in a Sun-like star's life to a human lifetime, it would correspond to about the last hour of our life. The whole display becomes part of the dusty galaxy in about 10,000 years.

Planetary nebulae help enrich the galaxy with elements like carbon and nitrogen that may eventually become the seeds of new planets.

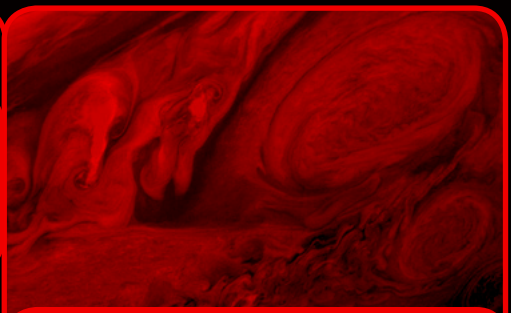
Index

National Aeronautics and
Space Administration

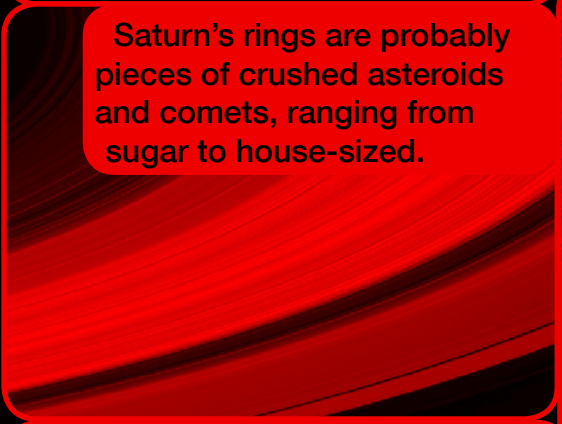
PLANET



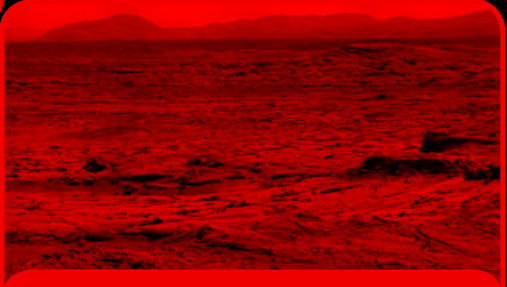
Venus is closer to the Sun than we are, giving us different views of the half-lit sphere over time.



The visible features on Jupiter are mostly ammonia clouds.

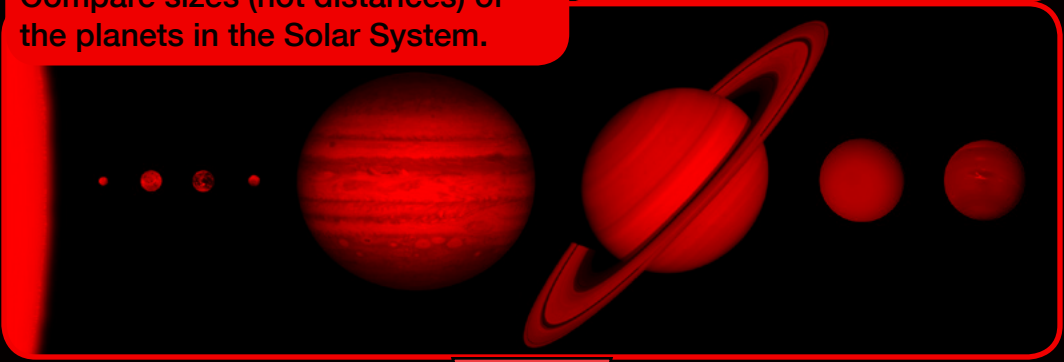


Saturn's rings are probably pieces of crushed asteroids and comets, ranging from sugar to house-sized.



Rovers on Mars give great views, but only see a small portion of the planet. Imagine trying to learn all about Earth from a golf cart.

Compare sizes (not distances) of the planets in the Solar System.



Index

PLANET

Examples of Planets

Venus: Named for the Roman goddess of love and beauty, Venus would not be our first choice for a romantic get-away. It is hot enough to melt lead and has a crushing atmosphere of carbon dioxide and acid rain.

Mars: The planet's reddish hue is caused by rust on the surface and dust in the atmosphere. Missions to Mars reveal great channels and flood plains, likely carved by ancient water.

Jupiter: This gas giant forms a sort of miniature solar system, including many moons and a magnetic field, but the planet did not grow big enough to become a star. It would have needed about 80 times the mass for this.

Saturn: Saturn's days are only 10 hours long. This rapid spinning causes the planet to bulge around the equator. Here on Earth, we honor this planet every week with a Satur(n)day.

Planets, the ancient's "wandering stars"

Our Solar System divides nicely into four regions: the inner rocky planets, then the Asteroid Belt, the gas giant planets, and finally the small icy bodies beyond. Until we began discovering planets around other stars, we thought all planetary systems might look something like this. We were very wrong. See the "Stars with Planets" card for more information.

There are two Solar System planets that orbit the Sun within the habitable zone, where liquid water could exist – Earth and Mars. We have running water but Mars doesn't because it is missing an atmosphere.

The planets, Sun, and Moon all pass in front of the stars of the zodiac. That's why these constellations were important to ancient cultures.

Index

National Aeronautics and
Space Administration

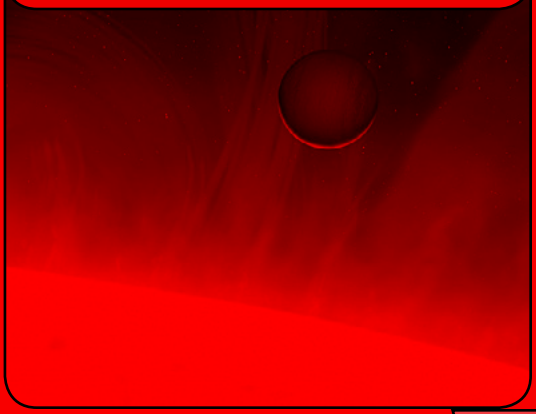
RED GIANT STAR

our Sun to scale

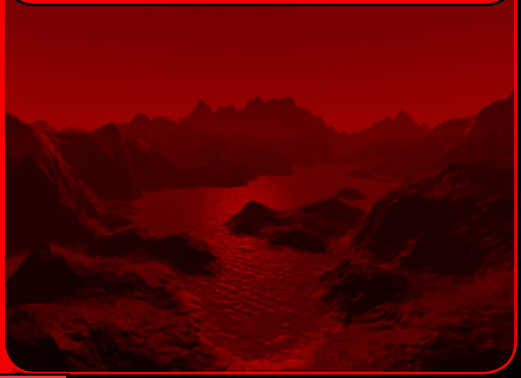
Red Giant Star
The Sun will eventually expand to this size, engulfing the inner planets.

Think of how big and important our Sun is to us here on Earth. Compared to red giant stars however, it seems downright puny. Even more astounding is the size of the red supergiants. On this scale, stars like Betelgeuse would be as tall and wide as an adult standing with arms outstretched.

When red giants expand, they may consume the planets in their systems. However, there is evidence of some planets surviving the giant stage. Here, an artist imagines a planet orbiting dangerously close to a red giant.



On the other hand, perhaps when the Sun becomes a red giant some of Jupiter's or Saturn's moons will heat up enough to melt their ice and potentially create a habitable place for life as we know it. We have plenty of time to work out spaceship designs.



Index

RED GIANT STAR

EXAMPLES OF RED GIANTS

Aldebaran in Taurus, Spring: It appears to be part of the V-shaped Hyades cluster but in fact is twice as far away as those stars. Think of how bright it would be if it were the same distance as the other stars!

Arcturus in Boötes, Summer: This bright star was called the "star of joy" by ancient Polynesian sailors. It helped them navigate the long distance to the Hawaii.

Betelgeuse* in Orion, Winter: This bright star formed millions of years ago in Orion's Belt and won't make it much past his shoulder at this rate. Centuries ago, Chinese astronomers recorded that this bright star was yellow, before it cooled to its present red color.

Antares* in Scorpius Summer/ Autumn: During the time of Confucius, the Chinese called this star Ta Ho, "The Great Fire."

Red giants are dying stars, cooling down and puffing up.

As stars use up all of their available fuel, they become cooler and expand, entering the giant phase. For a star like our Sun, this phase can last about 10% of its lifetime, or a billion years.

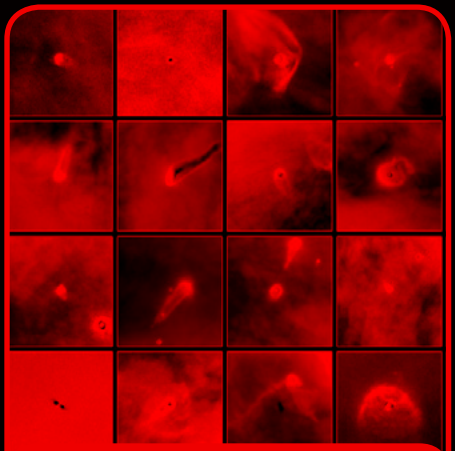
Our Sun will become a red giant in about 5 billion years. Mark your calendars! When that happens, it will get so big it could engulf Mercury, Venus, Earth, and maybe even Mars.

* Betelgeuse and Antares are red ***super***giants, also stars at the ends of their lives, but larger by far than the red giant (see comparison, reverse) These dying stars are so large that they will end their lives in a massive supernova explosion. When that happens, it will be so bright, we'll be able to see them during the day! But don't worry, they pose no danger to us.

Index

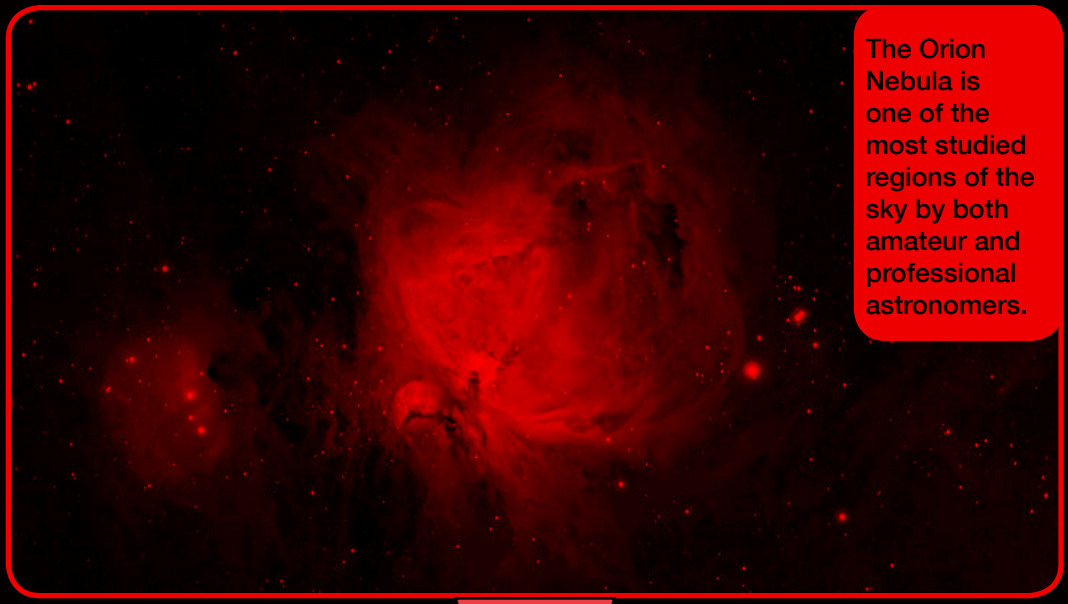
National Aeronautics and Space Administration

STAR NURSERY



As stars are born, some form planetary systems from the surrounding gas and dust. The Hubble Space Telescope spotted these seeds of future planets.

The Lagoon Nebula is located in the “steam” of the teapot asterism.



The Orion Nebula is one of the most studied regions of the sky by both amateur and professional astronomers.

Index

STAR NURSERY

EXAMPLES OF STAR NURSERIES

Orion Nebula in Orion's Sword, Winter/Spring: You can cover the star-forming region with your thumb extended at arm's length. There are many hundreds of stars being born here.

Lagoon Nebula (M8) in Sagittarius, Summer/Autumn: This nebula is very young and has probably created fewer than 100 stars so far. But it is active and creating more all the time.

Do you know where stars are born? In a star nursery!

Have you ever looked through the window of a hospital nursery full of newborn babies? You may have noticed that they're bundled in warm fleecy blankets. A star nursery is similar. Warm blankets of gas and dust surround these newborn stars.

A star nursery is a place where new stars are being born. This huge cloud of gas and dust is collapsing on itself to create new stars. Many of these new stars will have planets around them.

We're looking at stars in the very first part of their lives. If we compare the life of a star like our Sun to the life of a human, this stage would only last about the first month of our lives - earliest infancy.

That hazy warm gas and dust you see around these newborn stars might eventually develop into planets. Our star, the Sun, was born in a cloud like this. That wispy material eventually became planets, including Earth and everything on it!

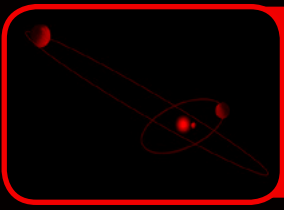
Where did this gas and dust come from? It's the remnants of dead stars. They exploded and flung their remains into the galaxy, recycling the material to make new stars and planets.

Index

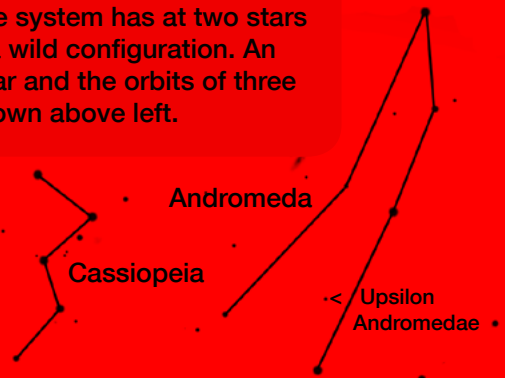
DRAFT VERSION

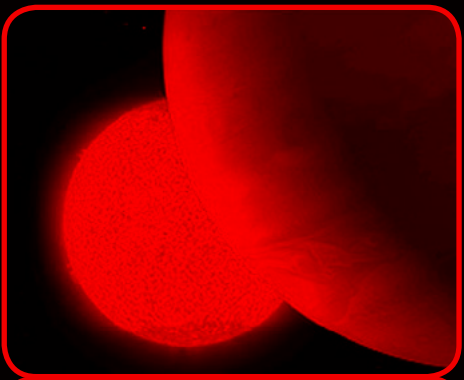
National Aeronautics and Space Administration

STAR WITH PLANETS

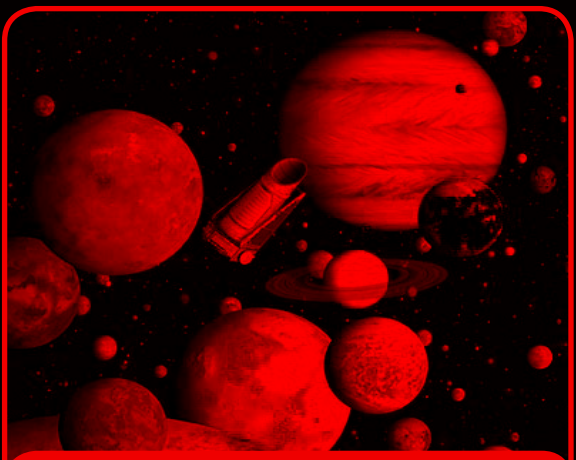


Upsilon Andromedae system has at two stars and four planets in a wild configuration. An illustration of one star and the orbits of three inner planets are shown above left.

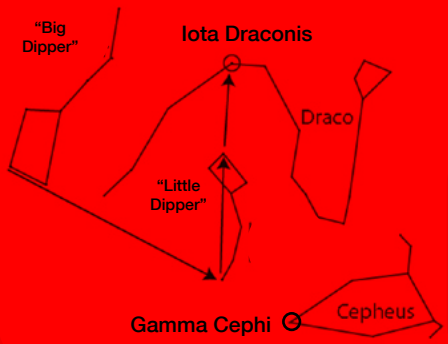




This artist's conception shows what the planet around that iota Draconis might look like if we were able to see it.
The star **iota Draconis** can easily be found from the Little Dipper.



Artist Lynette Cook imagines worlds around other stars as seen by Kepler.



Gamma Cephi can be found by following the line from the Big Dipper through Polaris and through to the next star. It is a double star with at least one gas giant planet orbiting the main star we see.

Index

STAR WITH PLANETS

EXAMPLES OF VISIBLE STARS WITH PLANETS

Iota Draconis, visible all year: This star's huge planet was the first planet discovered orbiting a giant star.

Gamma Cephei, visible all year: This double-star system will become the new "north star" in about 1,000 years. Its gas giant planet orbits the brighter star every 2-1/2 years. The second star is a dim red dwarf orbiting the brighter star once every sixty years or so.

Pollux in Gemini, Winter: Pollux's huge planet causes the star to wobble back and forth every year and a half. Detecting that wobble is how scientists found the planet. In the same way, other stars in Gemini have also been discovered to have planets, but those stars are too dim to see with just our eyes.

Uplison Andromedae, Autumn: This was the first two-star system discovered to have multiple planets. The primary star of this system is similar to our Sun. But instead of 8 planets orbiting, it has another star and at least 4 gas giant planets, like Jupiter in orbit around it! There may be even more we haven't detected yet.

Visions of Other Worlds inspire Wonder: *Are We Alone?*

The planetary systems we are finding are stranger than we expected. There are giant, hot planets that orbit their stars in hours and even planets with no stars at all.

We can only see the starlight, not the planets orbiting it.

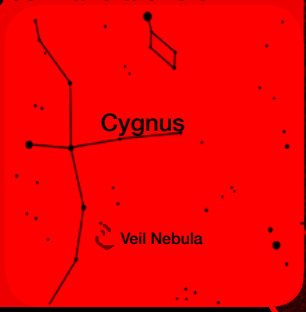
We're also finding rocky planets that might be the right temperature for liquid water. We don't know if there's life on any other planets, but it's fun to speculate. Can you imagine someone out there looking back?

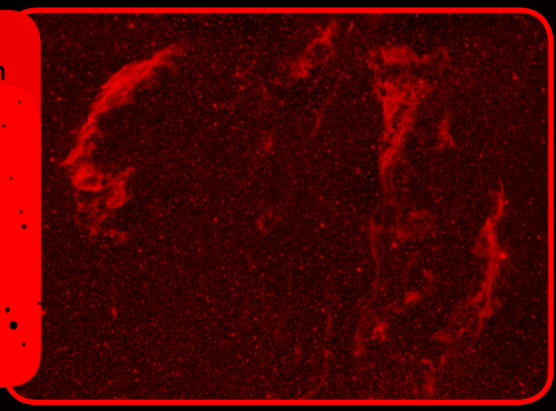
Index

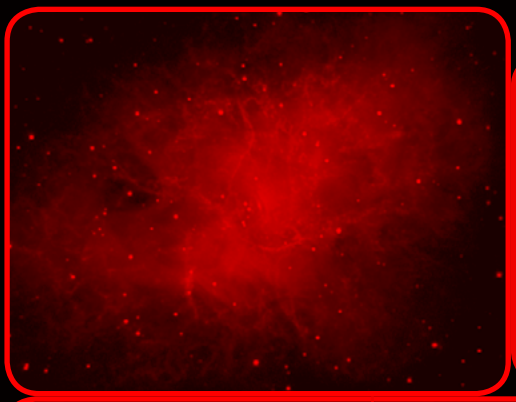
National Aeronautics and
Space Administration

SUPERNOVA REMNANT

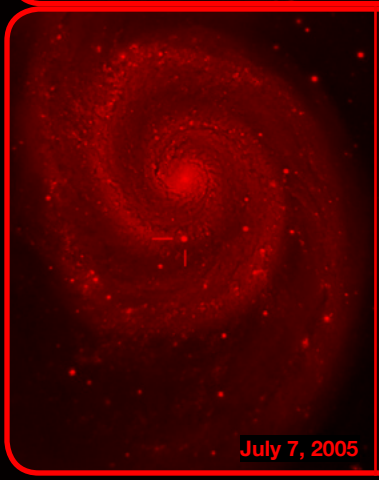
The Veil Nebula covers a large area of the night sky. If you make a circle with your thumb and index finger and hold it out toward the constellation Cygnus, the supernova remnant would fit inside that circle.

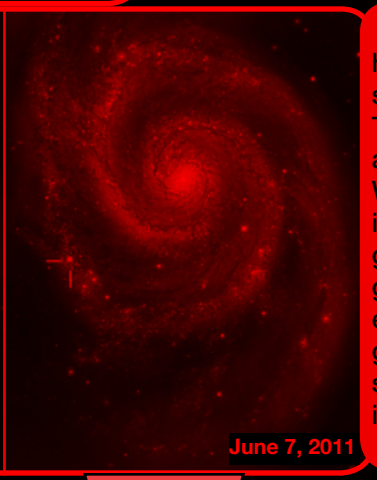






While looking for Halley's Comet in 1758, Charles Messier saw the Crab Nebula and thought it might be a comet. After noting that it did not move for many days, he was inspired to create a list of faint fuzzy objects that could be mistaken for comets. Ultimately, there were 110 objects and the Crab Nebula became Messier 1, or M1.





The Whirlpool Galaxy has had a few recent supernova explosions. Two from 2005 and 2011 are shown here, left. We can't usually see individual stars in other galaxies but when a star goes supernova, it can even outshine the whole galaxy. (The stars you see in these images are in our own galaxy and along our line of sight.)

Index

SUPERNOVA REMNANT

EXAMPLES OF SUPERNOVAE

Crab Nebula (M1), Autumn:
We see the remains of a massive star that ended its life in a huge explosion almost 1,000 years ago. Chinese astronomers observed this supernova as it became visible in the year 1054. It was called a “guest star” because it appeared suddenly as a bright dot in the sky, visible even in the daytime. It remained visible at night for about two years.

Veil Nebula, Summer:
This supernova remnant began with a giant stellar explosion around 5,000-10,000 years ago. Perhaps some of the first humans to develop agriculture saw a daytime star as they were planting. The moment is lost to history as it occurred before the written record.

A supernova is the ultimate recycling machine.

When we look up, many of the stars we see will eventually go supernova. We will see a bright star for a few months to years and eventually a remnant like these. Betelgeuse could go anytime - tonight or a million years from now. It would look really bright and would probably even be visible during the day, but wouldn’t hurt us. A supernova would have to go off within about 30 light-years to damage life on Earth. This one will happen at more than 20 times that distance.

The last supernova observed in our galaxy was in 1604, but it’s estimated that an average of 3 go off in our galaxy every year. They mostly explode in dusty regions, obscuring our view. It is one object that can be easier to detect in distant galaxies.

Supernovae are the reason rocky planets like Earth exist at all. These huge explosions create the heavier elements like oxygen, iron, and calcium. Without these elements, trees, rocks, and people could not exist.

Index