Background on HST Images on Lesson Slides Disk

- **Information given in same order as images in HST directory on lesson slides on disk.**
- **Information taken from STScI's hubblesite.org.**
- **Image numbers from STScI's catalogue.**

Einstein Cross, Image 1990-20

The European Space Agency's Faint Object Camera on board NASA's Hubble Space Telescope has provided astronomers with the most detailed image ever taken of the gravitational lens G2237 + 0305--sometimes referred to as the "Einstein Cross." The photograph shows four images of a very distant quasar which has been multiple-imaged by a relatively nearby galaxy acting as a gravitational lens.

Black Eye Galaxy, 2004-04

A collision of two galaxies has left a merged star system with an unusual appearance as well as bizarre internal motions. Messier 64 (M64) has a spectacular dark band of absorbing dust in front of the galaxy's bright nucleus, giving rise to its nicknames of the "Black Eye" or "Evil Eye" galaxy.

Dusty Spiral Galaxy, NGC 1275, Image 2003-14

A dusty spiral galaxy appears to be rotating on edge, like a pinwheel, as it slides through the larger, bright galaxy NGC 1275, in this HST image. These images show traces of spiral structure accompanied by dramatic dust lanes and bright blue regions that mark areas of active star formation.

Face On Galaxy, NGC 4622, Image 2002-03

Astronomers have found a spiral galaxy that may be spinning to the beat of a different cosmic drummer. To the surprise of astronomers, the galaxy, called NGC 4622, appears to be rotating in the opposite direction to what they expected. Pictures from NASA's Hubble Space Telescope helped astronomers determine that the galaxy may be spinning clockwise by showing which side of the galaxy is closer to Earth. This Hubble telescope photo of the oddball galaxy is presented by the Hubble Heritage team. The image shows NGC 4622 and its outer pair of winding arms full of new stars [shown in blue].

HCG 87, Image 1999-31

This troupe of four galaxies, known as Hickson Compact Group 87 (HCG 87), is performing an intricate dance orchestrated by the mutual gravitational forces acting between them. The dance is a slow, graceful minuet, occurring over a time span of hundreds of millions of years.

This Hubble telescope image reveals complex details in the dust lanes of the group's largest galaxy member (HCG 87a), which is actually disk-shaped, but tilted so that we see it nearly edge-on. Both 87a and its elliptically shaped nearest neighbor (87b) have active galactic

nuclei, which are believed to harbor black holes that are consuming gas. A third group member, the nearby spiral galaxy 87c, may be undergoing a burst of active star formation. The three galaxies are so close to each other that gravitational forces disrupt their structure and alter their evolution.

Hoag's Object, Image 2002-21

A nearly perfect ring of hot, blue stars pinwheels about the yellow nucleus of an unusual galaxy known as Hoag's Object. This image from NASA's Hubble Space Telescope captures a face-on view of the galaxy's ring of stars, revealing more detail than any existing photo of this object. The entire galaxy is about 120,000 light-years wide, which is slightly larger than our Milky Way Galaxy. The blue ring, which is dominated by clusters of young, massive stars, contrasts sharply with the yellow nucleus of mostly older stars. What appears to be a "gap" separating the two stellar populations may actually contain some star clusters that are almost too faint to see. Curiously, an object that bears an uncanny resemblance to Hoag's Object can be seen in the gap at the one o'clock position. The object is probably a background ring galaxy.

Interacting Galaxies, Image 2000-34

What appears as a bird's head, leaning over to snatch up a tasty meal, is a striking example of a galaxy collision in NGC 6745. The "bird" is a large spiral galaxy, with its core still intact. It is peering at its "prey," a smaller passing galaxy (nearly out of the field of view at lower right). The bright blue beak and bright, whitish-blue top feathers show the distinct path taken during the smaller galaxy's journey. These galaxies did not merely interact gravitationally as they passed one another; they actually collided.

Merging Galaxies, NGC 2207 and IC 2163, Image 1999-41

The Hubble telescope has caught a cosmic dance between two spiral galaxies. The larger galaxy, NGC 2207, is on the left; the smaller one, IC 2163, is on the right. Their dance has already caused quite a stir. Strong gravitational forces from NGC 2207 have distorted the shape of its smaller dance partner, flinging out stars and gas into long streamers that extend 100,000 light-years toward the right-hand edge of the picture. Eventually this dance will end. Billions of years from now the two galaxies will become one.

NGC 1705, Image 2003-07

The central region of the small galaxy NGC 1705 blazes with the light of thousands of young and old stars in this image, taken by NASA's Hubble Space Telescope. At 17 million light-years away, the individual stars of the dwarf irregular galaxy NGC 1705 are out of range of all but the sharp eyes of Hubble. NGC 1705 is classified as a dwarf irregular because it is small and lacks any regular structure.

Galaxy NGC 4013, Image 2001-07

The Hubble telescope has snapped this remarkable view of a perfectly "edge-on" galaxy, NGC 4013. This new Hubble picture reveals with exquisite detail huge clouds of dust and gas extending along, as well as far above, the galaxy's main disk. NGC 4013 is a spiral galaxy, similar to our Milky Way, lying some 55 million light-years from Earth in the direction

of the constellation Ursa Major. Viewed face-on, it would look like a nearly circular pinwheel, but NGC 4013 happens to be seen edge-on from our vantage point. Even at 55 million light-years, the galaxy is larger than Hubble's field of view, and the image shows only a little more than half of the object, albeit with unprecedented detail.

Polar-Ring Galaxy, NGC 4650A, Image 1999-16

Located about 130 million light-years away, NGC 4650A is one of only 100 known polar-ring galaxies. Their unusual disk-ring structure is not yet understood fully. One possibility is that polar rings are the remnants of colossal collisions between two galaxies sometime in the distant past, probably at least 1 billion years ago. What is left of one galaxy has become the rotating inner disk of old red stars in the center.

Meanwhile, another smaller galaxy, which ventured too close, was probably severely damaged or destroyed. During the collision the gas from the smaller galaxy would have been stripped off and captured by the larger galaxy, forming a new ring of dust, gas, and stars, which orbit around the inner galaxy almost at right angles to the old disk. This is the polar ring that we see almost edge-on in this Hubble telescope view.

Sombrero Galaxy, 2003-28

One of the largest Hubble mosaics ever assembled, this magnificent galaxy has a diameter that is nearly one-fifth the diameter of the full moon. The team used Hubble's Advanced Camera for Surveys to take six pictures of the galaxy and then stitched them together to create the final composite image. The photo reveals a myriad of stars in a pancake-shaped disk as well as a glowing central bulge of stars.

Spiral Arms, Galaxy NGC 2787, Image 2002-07

Tightly wound, almost concentric arms of dark dust encircle the bright nucleus of the galaxy NGC 2787 in this HST image. In astronomer Edwin Hubble's galaxy classification scheme, NGC 2787 is classified as an SB0, a barred lenticular galaxy. These lens-shaped galaxies show little or no evidence of the grand spiral arms that occur in their more photogenic cousins, though NGC 2787 does sport a faint bar, not apparent in this image.

Spiral Galaxy in Coma Berenices, Image 1999-25

The Key Project team used this Hubble telescope view of the magnificent spiral galaxy, NGC 4414, to help calculate the expansion rate of the universe.

Based on their discovery and careful brightness measurements of variable stars in this galaxy, the Key Project astronomers were able to make an accurate determination of the distance to the galaxy. The resulting distance to NGC 4414, about 60 million light-years, along with similarly determined distances to other nearby galaxies, contributes to astronomers' overall knowledge of the expansion rate of the cosmos, and helps them determine the age of the universe.

Spiral Galaxy in Leo, 2003-24

Amid a backdrop of far-off galaxies, the majestic dusty spiral NGC 3370 looms in the

foreground in this NASA Hubble Space Telescope image. Recent observations taken with the Advanced Camera for Surveys show intricate spiral arm structure spotted with hot areas of new star formation. But this galaxy is more than just a pretty face. Nearly 10 years earlier, NGC 3370, located in the constellation Leo, hosted a bright exploding star.

Globular Cluster in Ara, Image 2003-21

This HST view of the core of one of the nearest globular star clusters, called NGC 6397, resembles a treasure chest of glittering jewels. The cluster is located 8,200 light-years away in the constellation Ara. Here the stars are jam-packed together. The stellar density is about a million times greater than in our Sun's stellar neighborhood. The stars in NGC 6397 are also in constant motion, like a swarm of angry bees. The ancient stars are so crowded together that a few of them inevitably collide with each other once in a while. Near misses are even more common.

Globular Cluster Omega Centauri, Image 2001-33

Astronomers have used NASA's Hubble Space Telescope to peer into the center of a dense swarm of stars called Omega Centauri. Located some 17,000 light-years from Earth, Omega Centauri is a massive globular star cluster, containing several million stars swirling in locked orbits around a common center of gravity. The stars are packed so densely in the cluster's core that it is difficult for ground-based telescopes to make out individual stars. Hubble's high resolution is able to pick up where ground-based telescopes leave off, capturing distinct points of light from stars at the very center of the cluster.

Light Echo, V838 Monocerotis, Image 2003-10

In January 2002, a dull star in an obscure constellation suddenly became 600,000 times more luminous than our Sun, temporarily making it the brightest star in our Milky Way galaxy. The mysterious star, called V838 Monocerotis, has long since faded back to obscurity. But observations by the HST of a phenomenon called a "light echo" around the star have uncovered remarkable new features. These details promise to provide astronomers with a CAT-scan-like probe of the three-dimensional structure of shells of dust surrounding an aging star.

Ant Nebula, Image 2001-05

From ground-based telescopes, this cosmic object -- the glowing remains of a dying, Sun-like star -- resembles the head and thorax of a garden-variety ant. But this dramatic Hubble telescope image of the so-called "ant nebula" (Menzel 3, or Mz 3) shows even more detail, revealing the "ant's" body as a pair of fiery lobes protruding from the dying star.

Egg Nebula, Image 2003-09

Resembling a rippling pool illuminated by underwater lights, the Egg Nebula offers astronomers a special look at the normally invisible dust shells swaddling an aging star. These dust layers, extending over one-tenth of a light-year from the star, have an onion skin structure that forms concentric rings around the star. A thicker dust belt, running almost vertically through the image, blocks off light from the central star. Twin beams of light radiate from the hidden star and illuminate the pitch-black dust, like a flashlight shining in a smoky

room.

Hubble-V, Image 2001-39

Resembling curling flames from a campfire, this magnificent nebula in a neighboring galaxy is giving astronomers new insight into the fierce birth of stars, which may have been more a typical occurrence in the early universe. The glowing gas cloud, called Hubble-V, has a diameter of about 200 light-years. A faint tail of gas trailing off the top of this Hubble Space Telescope image sits opposite a dense cluster of bright stars at the bottom of the irregularly shaped nebula.

Nebula NGC 6751 in Aquila, Image 2000-12

Glowing in the constellation Aquila like a giant eye, the nebula is a cloud of gas ejected several thousand years ago from the hot star visible in its center.

"Planetary nebulae" are named after their round shapes as seen visually in small telescopes, and have nothing else to do with planets. They are shells of gas thrown off by stars of masses similar to that of our own Sun, when the stars are nearing the ends of their lives. The loss of the outer layers of the star into space exposes the hot stellar core, whose strong ultraviolet radiation then causes the ejected gas to fluoresce as the planetary nebula. Our own Sun is predicted to eject its planetary nebula some 6 billion years from now.

The nebula shows several remarkable and poorly understood features. Blue regions mark the hottest glowing gas, which forms a roughly circular ring around the central stellar remnant. Orange and red show the locations of cooler gas. The cool gas tends to lie in long streamers pointing away from the central star, and in a surrounding, tattered-looking ring at the outer edge of the nebula. The origin of these cooler clouds within the nebula is still uncertain, but the streamers are clear evidence that their shapes are affected by radiation and stellar winds from the hot star at the center. The star's surface temperature is estimated at a scorching 140,000 degrees Celsius (250,000 degrees Fahrenheit).

Due to the expansion of the nebula, at a speed of about 40 kilometers per second (25 miles per second), the high resolution of Hubble's camera will reveal the slight increase in the size of the nebula since 1998. This measurement will allow the astronomers to calculate an accurate distance to NGC 6751. In the meantime, current estimates are that NGC 6751 is roughly 6,500 light-years from Earth. The nebula's diameter is 0.8 light-years, some 600 times the diameter of our own solar system.

Nebula in NGC 6822, Image 2001-01

In this image, X marks the location of Hubble-X, a glowing gas cloud in one of the most active star-forming regions in galaxy NGC 6822. The galaxy lies 1.6 million light-years from Earth in the constellation Sagittarius, one of the Milky Way's closest neighbors. This hotbed of star birth is similar to the fertile regions in the Orion Nebula in our Milky Way Galaxy, but on a vastly greater scale. The intense star birth in Hubble-X occurred about 4 million years ago, a small fraction of the approximate 10-billion-year age of the universe.

Keyhole Nebula, Image 2000-06

When 19th century astronomer Sir John Herschel spied a swirling cloud of gas with a hole punched through it, he dubbed it the Keyhole Nebula. Now the Hubble telescope has taken a peek at this region, and the resulting image reveals previously unseen details of the Keyhole's mysterious, complex structure. The Keyhole is part of a larger region called the Carina Nebula (NGC 3372), about 8,000 light-years from Earth.

The keyhole is the circular feature that dominates the picture and is about 7 light-years wide. The round structure contains bright filaments of hot, glowing gas and dark silhouetted clouds of cold molecules and dust, all of which are in rapid, chaotic motion. Hubble's clear view also shows several small, dark globules that may be in the process of collapsing to form new stars. This region is a rich breeding ground for some of the hottest and most massive stars known, each about 10 times as hot and 100 times as hefty as the Sun. The famous explosive variable star Eta Carinae also lies just outside the upper right of the picture.

Little Ghost Nebula, NGC 6369, Image 2002-25

NASA's Hubble Space Telescope has caught a glimpse of a colorful cosmic ghost, the glowing remains of a dying star called NGC 6369. The glowing apparition is known to amateur astronomers as the "Little Ghost Nebula," because it appears as a small, ghostly cloud surrounding the faint, dying central star.

N81, Image 2000-30

The Hubble telescope has peered deep into a neighboring galaxy to reveal details of the formation of new stars. Hubble's target was a newborn star cluster within the Small Magellanic Cloud, a small satellite galaxy of our Milky Way. The picture shows young, brilliant stars cradled within a nebula, or glowing cloud of gas, cataloged as N 81.

NGC 604, Image 2003-30

This festively colorful nebula, called NGC 604, is one of the largest known seething cauldrons of star birth seen in a nearby galaxy. NGC 604 is similar to familiar star-birth regions in our Milky Way galaxy, such as the Orion Nebula, but it is vastly larger in extent and contains many more recently formed stars. This monstrous star-birth region contains more than 200 brilliant blue stars within a cloud of glowing gases some 1,300 light-years across, nearly 100 times the size of the Orion Nebula.

Pencil Nebula, Image 2003-16

Remnants from a star that exploded thousands of years ago created a celestial abstract portrait, as captured in this NASA Hubble Space Telescope image of the Pencil Nebula. Officially known as NGC 2736, the Pencil Nebula is part of the huge Vela supernova remnant, located in the southern constellation Vela. Discovered by Sir John Herschel in the 1840s, the nebula's linear appearance triggered its popular name. The nebula's shape suggests that it is part of the supernova shock wave that recently encountered a region of dense gas. It is this interaction that causes the nebula to glow, appearing like a rippled sheet.

The nebula's luminous appearance comes from dense gas regions that have been struck by the supernova shock wave. As the shock wave travels through space [from right to left in the

image], it rams into interstellar material. Initially the gas is heated to millions of degrees, but then subsequently cools down, emitting the optical light visible in the image.

The colors of the various regions in the nebula yield clues about this cooling process. Some regions are still so hot that the emission is dominated by ionized oxygen atoms, which glow blue in the picture. Other regions have cooled more and are seen emitting red in the image (cooler hydrogen atoms). In this situation, color shows the temperature of the gas. The nebula is visible in this image because it is glowing.

The supernova explosion left a spinning pulsar at the core of the Vela region. Based on the rate at which the pulsar is slowing down, astronomers estimate that the explosion may have occurred about 11,000 years ago. Although no historical records of the blast exist, the Vela supernova would have been 250 times brighter than Venus and would have been easily visible to southern observers in broad daylight. The age of the blast, if correct, would imply that the initial explosion pushed material from the star at nearly 22 million miles per hour. As the Vela supernova remnant expands, the speed of its moving filaments, such as the Pencil Nebula, decreases. The Pencil Nebula, for example, is moving at roughly 400,000 miles per hour.

Reflection Nebula N30B, Image 2002-29

A unique peanut-shaped cocoon of dust, called a reflection nebula, surrounds a cluster of young, hot stars in this view from NASA's Hubble Space Telescope. The "double bubble," called N30B, is inside a larger nebula, named DEM L 106. The larger nebula is embedded in the Large Magellanic Cloud, a satellite galaxy of our Milky Way located 160,000 light-years away. The wispy filaments of DEM L 106 fill much of the image. The hot stars are inside the double bubble. Hubble captures the brilliant blue-white colors of these stars. The very bright star at the top of the picture, called Henize S22, illuminates the dusty cocoon like a flashlight shining on smoke particles. This searing supergiant star is only 25 light-years from the N30B nebula. Viewed from N30B, the brilliant star would appear 250 times brighter than the planet Venus does in our sky.

Reflection Nebula in Orion, Image 2000-10

Just weeks after NASA astronauts repaired the Hubble Space Telescope in December 1999, the Hubble Heritage Project snapped this picture of NGC 1999, a nebula in the constellation Orion.

NGC 1999 is an example of a reflection nebula. Like fog around a street lamp, a reflection nebula shines only because the light from an embedded source illuminates its dust; the nebula does not emit any visible light of its own. NGC 1999 lies close to the famous Orion Nebula, about 1,500 light-years from Earth, in a region of our Milky Way galaxy where new stars are being formed actively. The nebula is famous in astronomical history because the first Herbig-Haro object was discovered immediately adjacent to it (it lies just outside the new Hubble image). Herbig-Haro objects are now known to be jets of gas ejected from very young stars.

The NGC 1999 nebula is illuminated by a bright, recently formed star, visible in the Hubble photo just to the left of center. This star is cataloged as V380 Orionis, and its white color is due to its high surface temperature of about 10,000 degrees Celsius (nearly twice that of our

own Sun). Its mass is estimated to be 3.5 times that of the Sun. The star is so young that it is still surrounded by a cloud of material left over from its formation, here seen as the NGC 1999 reflection nebula.

The WFPC2 image of NGC 1999 shows a remarkable jet-black cloud near its center, resembling a letter T tilted on its side, located just to the right and lower right of the bright star. This dark cloud is an example of a "Bok globule," named after the late University of Arizona astronomer Bart Bok. The globule is a cold cloud of gas, molecules, and cosmic dust, which is so dense it blocks all of the light behind it. In the Hubble image, the globule is seen silhouetted against the reflection nebula illuminated by V380 Orionis. Astronomers believe that new stars may be forming inside Bok globules, through the contraction of the dust and molecular gas under their own gravity.

NGC 1999 was discovered some two centuries ago by Sir William Herschel and his sister Caroline, and was cataloged later in the 19th century as object 1999 in the New General Catalogue.

Nebula Region in LMC, N44C, Image 2002-12

N44C is the designation for a region of ionized hydrogen gas surrounding an association of young stars in the Large Magellanic Cloud (LMC), a nearby, small companion galaxy to the Milky Way visible from the Southern Hemisphere. N44C is part of the larger N44 complex, which includes young, hot, massive stars, nebulae, and a "superbubble" blown out by multiple supernova explosions.

Retina Nebula, Image 2002-14

The Hubble telescope reveals a rainbow of colors in this dying star, called IC 4406. Like many other so-called planetary nebulae, IC 4406 exhibits a high degree of symmetry. The nebula's left and right halves are nearly mirror images of the other. If we could fly around IC 4406 in a spaceship, we would see that the gas and dust form a vast donut of material streaming outward from the dying star. We don't see the donut shape in this photograph because we are viewing IC 4406 from the Hubble telescope. From this vantage point, we are seeing the side of the donut. This side view allows us to see the intricate tendrils of material that have been compared to the eye's retina. In fact, IC 4406 is dubbed the "Retina Nebula."

Ring Nebula, Image 1999-01

The NASA Hubble Space Telescope has captured the sharpest view yet of the most famous of all planetary nebulae: the Ring Nebula (M57). In this October 1998 image, the telescope has looked down a barrel of gas cast off by a dying star thousands of years ago. This photo reveals elongated dark clumps of material embedded in the gas at the edge of the nebula; the dying central star floating in a blue haze of hot gas. The nebula is about a light-year in diameter and is located some 2,000 light-years from Earth in the direction of the constellation Lyra.

The colors are approximately true colors. The color image was assembled from three black-and-white photos taken through different color filters with the Hubble telescope's Wide Field Planetary Camera 2. Blue isolates emission from very hot helium, which is located primarily

close to the hot central star. Green represents ionized oxygen, which is located farther from the star. Red shows ionized nitrogen, which is radiated from the coolest gas, located farthest from the star. The gradations of color illustrate how the gas glows because it is bathed in ultraviolet radiation from the remnant central star, whose surface temperature is a white-hot 216,000 degrees Fahrenheit (120,000 degrees Celsius).

Southern Ring Nebula, Image 1998-39

NGC 3132 is a striking example of a planetary nebula. This expanding cloud of gas surrounding a dying star is known to amateur astronomers in the Southern Hemisphere as the "Eight-Burst" or the "Southern Ring" Nebula.

The name "planetary nebula" refers only to the round shape that many of these objects show when examined through a small telescope. In reality, these nebulae have little or nothing to do with planets, but are instead huge shells of gas ejected by stars as they near the ends of their lifetimes. NGC 3132 is nearly half a light year in diameter, and at a distance of about 2,000 light-years is one of the nearest known planetary nebulae. The gases are expanding away from the central star at a speed of 9 miles per second.

Spirograph Nebula, Image 2000-28

Glowing like a multi-faceted jewel, the planetary nebula IC 418 lies about 2,000 light-years from Earth in the direction of the constellation Lepus.

A planetary nebula represents the final stage in the evolution of a star similar to our Sun. The star at the center of IC 418 was a red giant a few thousand years ago, but then ejected its outer layers into space to form the nebula, which has now expanded to a diameter of about 0.1 light-year. The stellar remnant at the center is the hot core of the red giant, from which ultraviolet radiation floods out into the surrounding gas, causing it to fluoresce. Over the next several thousand years, the nebula will gradually disperse into space, and then the star will cool and fade away for billions of years as a white dwarf. Our own Sun is expected to undergo a similar fate, but fortunately this will not occur until some 5 billion years from now.

The Hubble image of IC 418 is shown in a false-color representation, based on Wide Field Planetary Camera 2 exposures taken in February and September, 1999 through filters that isolate light from various chemical elements. Red shows emission from ionized nitrogen (the coolest gas in the nebula, located furthest from the hot nucleus), green shows emission from hydrogen, and blue traces the emission from ionized oxygen (the hottest gas, closest to the central star). The remarkable textures seen in the nebula are newly revealed by the Hubble telescope, and their origin is still uncertain.

Tarantula Nebula, Image 1999-12

In the most active starburst region in the local universe lies a cluster of brilliant, massive stars, known to astronomers as Hodge 301.

Hodge 301, seen in the lower right hand corner of this image, lives inside the Tarantula Nebula in our galactic neighbor, the Large Magellanic Cloud.

This star cluster is not the brightest, or youngest, or most populous star cluster in the Tarantula Nebula; that honor goes to the spectacular R136. In fact, Hodge 301 is almost 10 times older than the young cluster R136.

But age has its advantages; many of the stars in Hodge 301 are so old that they have exploded as supernovae. These exploded stars are blasting material out into the surrounding region at speeds of almost 200 miles per second. This high speed ejecta are plowing into the surrounding Tarantula Nebula, shocking and compressing the gas into a multitude of sheets and filaments, seen in the upper left portion of the picture.

Note for your calendar; Hodge 301 contains three red supergiants - stars that are close to the end of their evolution and are about to go supernova, exploding and sending more shocks into the Tarantula.

Also present near the center of the image are small, dense gas globules and dust columns where new stars are being formed today, as part of the overall ongoing star formation throughout the Tarantula region.

Thackeray's Globules, Image 2002-01

Strangely glowing dark clouds float serenely in this remarkable and beautiful image. These dense, opaque dust clouds, known as "globules," are silhouetted against nearby bright stars in the busy star-forming region IC 2944. Astronomer A.D. Thackeray first spied the globules in IC 2944 in 1950. Globules like these have been known since astronomer Bart Bok first drew attention to such objects in 1947. But astronomers still know very little about their origin and nature, except that they are generally associated with areas of star formation, called "HII regions" due to the presence of hydrogen gas. IC 2944 is filled with gas and dust that is illuminated and heated by a loose cluster of massive stars. These stars are much hotter and much more massive than our Sun.

Supernova Remnant 1987A, Image 1999-04

Glittering stars and wisps of gas create a breathtaking backdrop for the self-destruction of a massive star, called supernova 1987A, in the Large Magellanic Cloud, a nearby galaxy. Astronomers in the Southern hemisphere witnessed the brilliant explosion of this star on February 23, 1987.

The many bright blue stars nearby the supernova are massive stars, each more than six times heftier than our Sun. They are members of the same generation of stars as the star that went supernova about 12 million years ago. The presence of bright gas clouds is another sign of the youth of this region, which still appears to be a fertile breeding ground for new stars.

In a few years the supernova's fast moving material will sweep the inner ring with full force, heating and exciting its gas, and will produce a new series of cosmic fireworks that will offer a striking view for more than a decade.

Supernova Remnant Cassiopeia A, Image 2002-15

Glowing gaseous streamers of red, white, and blue, as well as green and pink, illuminate the

heavens like Fourth of July fireworks. The colorful streamers that float across the sky in this image were created by the universe's biggest firecracker, the titanic supernova explosion of a massive star. The light from the exploding star reached Earth 320 years ago, nearly a century before our United States celebrated its birth with a bang. The dead star's shredded remains are called Cassiopeia A, or "Cas A" for short. Cas A is the youngest known supernova remnant in our Milky Way Galaxy and resides 10,000 light-years away in the constellation Cassiopeia, so the star actually blew up 10,000 years before the light reached Earth in the late 1600s.

Supernova Remnant in LMC, Image 2003-20

Resembling the puffs of smoke and sparks from a summer fireworks display in this image from NASA's Hubble Space Telescope, these delicate filaments are actually sheets of debris from a stellar explosion in a neighboring galaxy. Hubble's target was a supernova remnant, denoted LMC N 49, within the Large Magellanic Cloud, a nearby, small companion galaxy to the Milky Way visible from the southern hemisphere. This filamentary material will eventually be recycled into building new generations of stars in the LMC. Our own Sun and planets are constructed from similar debris of supernovae that exploded in the Milky Way billions of years ago.

Supernova Remnant N132D, Image 1995-13

This is a Hubble telescope image of the tattered debris of a star that exploded 3,000 years ago as a supernova. This supernova remnant, called N132D, lies 169,000 light-years from Earth in the satellite galaxy, the Large Magellanic Cloud.

A Hubble snapshot of the supernova's inner regions shows the complex collisions that take place as fast-moving material slams into cool, dense interstellar clouds. This level of detail in the expanding filaments could only be seen previously in much closer supernova remnants. Now, Hubble's capabilities extend the detailed study of supernovae to the distance of a neighboring galaxy.

Survey, Chandra South, Image 2003-18

Two of NASA's Great Observatories, bolstered by the largest ground-based telescopes around the world, are beginning to harvest new clues to the origin and evolution of the universe's largest building blocks, the galaxies. It's a bit like finding a family scrapbook containing snapshots that capture the lives of family members from infancy through adolescence to adulthood. The Hubble Space Telescope has joined forces with the Chandra X-ray Observatory to survey a relatively broad swath of sky encompassing tens of thousands of galaxies stretching far back in time. Called the Great Observatories Origins Deep Survey (GOODS), astronomers are studying galaxy formation and evolution over a wide range of distances and ages.

Survey, Deep Field, Image 1996-01

Representing a narrow "keyhole" view stretching to the visible horizon of the universe, the Hubble Deep Field image covers a speck of the sky only about the width of a dime 75 feet away. Though the field is a very small sample of the heavens, it is considered representative of the typical distribution of galaxies in space, because the universe, statistically, looks

largely the same in all directions. Gazing into this small field, Hubble uncovered a bewildering assortment of at least 1,500 galaxies at various stages of evolution.

The image was assembled from 342 separate exposures taken with the Wide Field and Planetary Camera 2 (WFPC2) for ten consecutive days between December 18 and 28, 1995. Essentially a narrow, deep "core sample" of sky, the Hubble Deep Field (HDF) is analogous to a geologic core sample of the Earth's crust. Just as a terrestrial core sample is a history of events which took place as Earth's surface evolved, the HDF image contains information about the universe at many different stages in time. Unlike a geologic sample though, it is not clear what galaxies are nearby and therefore old, and what fraction are very distant and therefore existed when the universe was newborn.

The HDF team selected a piece of sky near the handle of the Big Dipper. The field is far from the plane of our Galaxy and so is "uncluttered" of nearby objects, such as foreground stars. The field provides a "peephole" out of the galaxy that allows for a clear view all the way to the horizon of the universe.

Test exposures made in early 1995 with Hubble and the 4-meter telescope at Kitt Peak National Observatory also confirmed the field is devoid of large galaxy clusters, which would interfere with seeing farther and fainter objects. The target field is, by necessity, in the continuous viewing zone of Hubble's orbit, a special region where Hubble can view the sky without being blocked by Earth or interference from the Sun or Moon.

Survey, Ultra Deep Field, 2004-07

On March 9, 2004, astronomers at the Space Telescope Science Institute unveiled the deepest portrait of the visible universe ever achieved by humankind. Called the Hubble Ultra Deep Field (HUDF), the million-second-long exposure reveals the first galaxies to emerge from the so-called "dark ages," the time shortly after the big bang when the first stars reheated the cold, dark universe. The image should offer new insights into what types of objects reheated the universe long ago.

This historic new view is actually two separate images taken by Hubble's Advanced Camera for Surveys (ACS) and the Near Infrared Camera and Multi-object Spectrometer (NICMOS). Both images reveal galaxies that are too faint to be seen by ground-based telescopes, or even in Hubble's previous faraway looks, called the Hubble Deep Fields (HDFs), taken in 1995 and 1998.