

**UPDATED
COMPACT EDITION**



The Stargazer's Handbook

The definitive field guide to the night sky

GILES SPARROW

Orion The Orion Nebula M42

Infant Stars

As one of the closest nearby star factories, the Orion Nebula offers a unique opportunity for astronomers to test their theories and look at the properties of newborn stars. One important feature they have identified is the near-ubiquity of protoplanetary discs or "proplyds." These dense clouds of gas and dust persist in orbit around stars even after they have begun to shine, and therefore seem to be an ideal source of raw materials for the later formation of solar systems.

Another significant Hubble discovery within the nebula is an abundance of lightweight brown dwarfs—"failed stars"—that never achieved sufficient mass to ignite nuclear fusion reactions, but still glow with heat from their formation.

R.A. 05h 35m, DEC. -05°27'
MAGNITUDE 4.0
DISTANCE 1,350 light years



Trapezium Cluster

At the heart of the Orion Nebula lies a tight cluster of stars that smaller telescopes show as a quadruple star system. The cluster, universally known as the Trapezium, was first reported by the Italian astronomer Galileo Galilei in his 1610 book *The Starry Messenger*, and while the number of stars in the cluster has steadily increased, the name has stuck. The five dominant stars of the Trapezium, shown in this Hubble Space Telescope image, each have masses between 15 and 30 times

that of the Sun. This ensures that they will live fast and die young, but for the moment the ultraviolet radiation they pour out into the surrounding nebulosity does much to illuminate the gas clouds.



Great Nebula

M42 is easily seen with the naked eye as a patch of fuzzy light just south of the multiple star system Theta Orionis in Orion's Sword. Many of the nebula's features can already be traced using just binoculars or a small telescope, although the nebula appears greenish

rather than pink. Larger telescopes only increase the levels of detail visible in this wonderful flower-like structure. As well as M42, Orion's Sword is home to several other interesting nebulae, though none is as bright and large as the so-called Great Nebula.

Jrsa Major Inside View



Mizar and Alcor Ursae Majoris

The middle star of the Bear's tail, Zeta Ursae Majoris or Mizar, is a renowned multiple star. Binoculars or even sharp eyesight reveal a magnitude-4.0 companion, Alcor, close to magnitude-2.3 Mizar, and even a small telescope will show that Mizar is itself binary. What's more, each of these three stars is a double star in turn. For a long time, the grouping of Mizar and Alcor was seen as mere chance, but new studies have suggested that the stars are genuinely bound by gravity, creating a sextuple system.

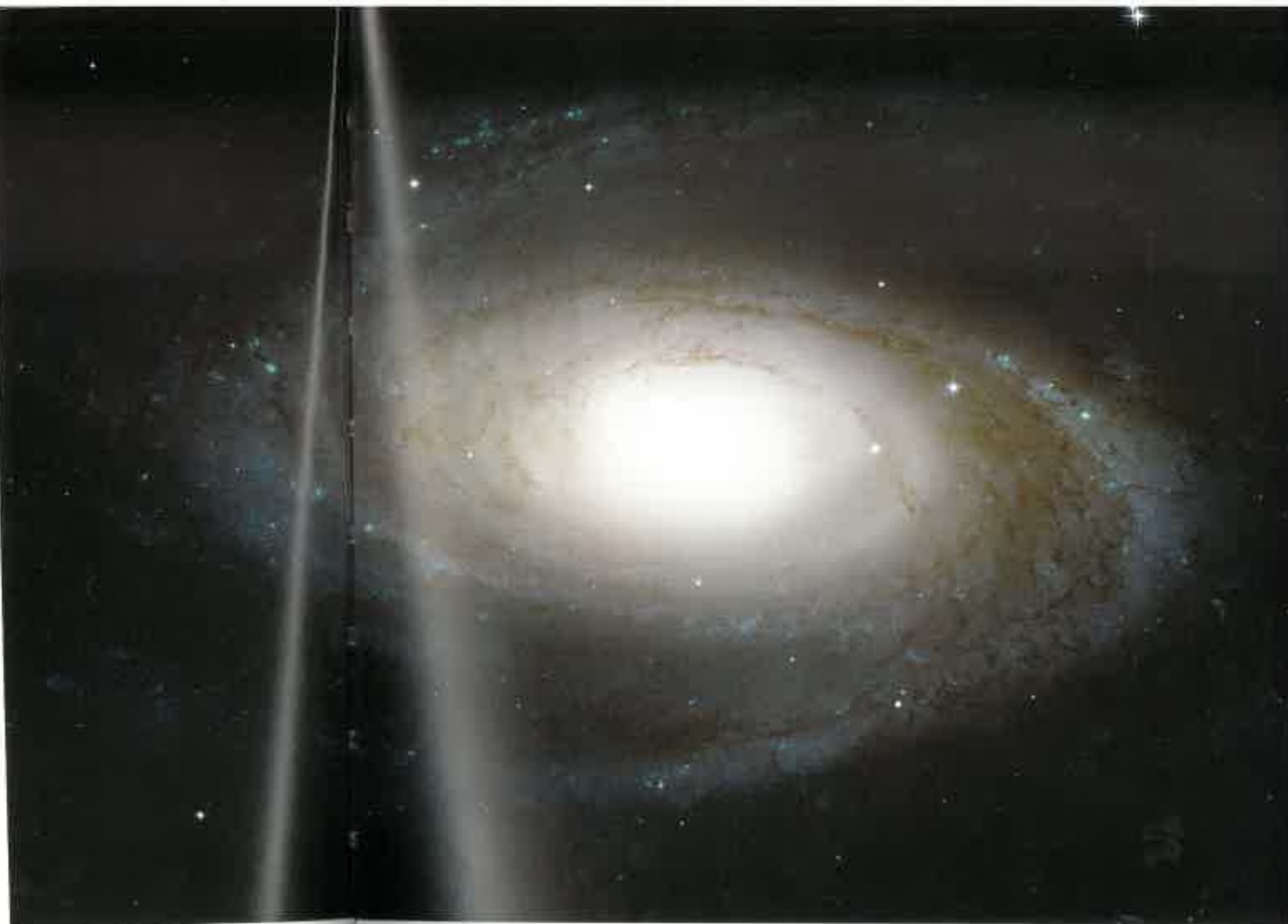
R.A. 13h 25m, DEC. +54°56'
MAGNITUDE 2.3, 4.0
DISTANCE 78 light years



Hubble Deep Field

Over ten days in December 1995, astronomers used the Hubble Space Telescope to take a series of images of a small patch of apparently empty sky in Ursa Major. Combining the multiple exposures using computerized image processing, NASA scientists produced the Hubble Deep Field (HDF)—a view that reveals some 3,000 galaxies stretching across billions of light years of space and offers a new perspective on the Universe.

R.A. 12h 37m, DEC. +62°12'
MAGNITUDE < 28
DISTANCE Up to 12 billion light years

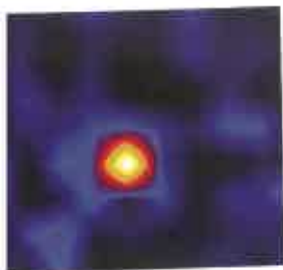


Bode's Galaxy Messier 81

This tightly wound spiral galaxy, 12 million light years from Earth, bears the name of Johann Elert Bode, the German astronomer who discovered it in 1774. Binoculars show it as a fuzzy point of light while a small telescope will reveal the oval shape of its central nucleus and larger instruments may trace its spiral arms. Although most of the light from its central regions is due to sheer density of stars, M81 also emits some radiation directly from its nucleus, making it one of the closest "active galaxies." It forms the core of one of the closest galaxy groups to our own.

R.A. 09h 56m, DEC. +69°04'
MAGNITUDE 6.9
DISTANCE 12 million light years

Cygnus Inside View



Cygnus X-1

X-ray observations of this object reveal a brilliant blue giant, reduced to a feeble 9th magnitude by its distance of more than 10,000 light years. However, X-ray studies show something else entirely—a source of high-energy X-rays emitting a thousand times per second. The rays do not come directly from the star, but from an otherwise invisible object that orbits it once every 5.6 days and weighs as much as 10 solar masses. This suggests that the primary object is probably a black hole pulling gas away from the visible star and forming a superhot disc of X-ray-emitting material that spirals inward to its doom.

R.A. 19h 58m, DEC. +35°12'
MAGNITUDE 8.9
DISTANCE 8,200 light years



Cygnus A

In visible light, this distant and distorted galaxy can only be detected through large telescopes, but for radio astronomers it is one of the brightest objects in the sky. A pair of tight jets emerge on opposite sides of the visible galaxy and billow out to form a huge double-lobed structure of radio-emitting gas half a million light years across. Cygnus A is one of the nearest and most powerful radio galaxies—a type of active galaxy in which the central supermassive black hole “engine” is hidden from view so that all we see are the effects of material ejected from above and below this central region.

R.A. 19h 59m, DEC. +40°44'
MAGNITUDE 15.0
DISTANCE 600 million light years

Albireo

β Cygni

Arguably the most beautiful double star in northern skies, Albireo is an observing treat through even the smallest telescope. The system comprises a yellow-orange star of magnitude 3.1 and a contrasting blue-green star of magnitude 5.1. Both stars lie around 385 light years from Earth, but astronomers have not confirmed that they are actually in orbit around each other. In 1976 astronomers confirmed that the brighter component, Albireo A, is itself binary, but its two elements are all but impossible to separate visually, even with professional equipment.

R.A. 19h 31m, DEC. +27°58'
MAGNITUDE 3.1/5.1
DISTANCE 385 light years



The Witch's Broom NGC 6960

The brightest section of the Veil Nebula, marking its western edge, is sometimes known as the Witch's Broom. Here the nebula's light is relatively concentrated, and the naked-eye star 52 Cygni (magnitude 5.3) acts as a useful pointer. This segment of the Veil is roughly 1.5 degrees across—three times the size of the Full Moon. At an estimated distance of almost 1,500 light years, meanwhile, the entire Veil complex covers a volume of space 50 light years across.

R.A. 20h 46m, DEC. +30°43'
MAGNITUDE 7.0
DISTANCE 1,470 light years

Sagittarius

Lying in one of the richest regions of the Milky Way, this constellation is strewn with numerous deep-sky objects ranging from nebulae to star clusters and the very center of our galaxy itself. The brightest stars of Sagittarius form a distinctive "teapot" shape in front of dense Milky Way starfields.

AT A GLANCE

NAME Sagittarius
MEANING The archer
ABBREVIATION Sgr
GENITIVE Sagittarii
R.A. 19h 06m
DEC. -28° 29'
AREA 867 (15)
BRIGHTEST STAR Kaus Australis (ε)

Several ancient civilizations saw it as a horse and rider, but the ancient Greeks identified Sagittarius as a centaur (half-man, half-horse) wielding a bow and arrow. The brightest star is Epsilon Sagittarii (Kaus Australis), a "white giant" star of magnitude 1.8 some 145 light years from Earth. Beta Sagittarii or Arkab, meanwhile, is a line-of-sight double consisting of blue and white stars at magnitudes 4.0 and 4.3, 380 and 140 light years away respectively. A small telescope will show a third component of magnitude 7.1.

Deep-sky highlights within Sagittarius include the Lagoon, Omega, and Trifid nebulae (M8, M17, and M20). The heart of the Milky Way, marked by the radio source Sagittarius A*, lies 26,000 light years away close to Gamma Sagittarii, but is hidden behind dense intervening star clouds.

Trifid Nebula

Dark canyons of dust divide this glowing gas cloud into three roughly equal parts and give the Trifid Nebula, Messier 20, its name. It lies around 5,200 light years from Earth and presents a rare and beautiful combination of a pinkish emission nebula, a blue reflection nebula, and a star cluster that provides the radiation to illuminate them both, glowing at just below naked-eye visibility.



Sagittarius Inside View

Alien Visitor Messier 54

At first glance this globular cluster seems to be a typical example of its type, but Messier 54 hides an extraordinary secret. Although the cluster has been recognized since Charles Messier first cataloged it in 1778, it was only in 1994 that astronomers analyzing the density of star clouds within and beyond the galactic



center identified the ghostly outline of a small galaxy in the process of colliding with our own. Recognition of this galaxy, the Sagittarius Dwarf Elliptical or SagDEG, led to the realization that M54 is associated with it—this is an extragalactic cluster in the process of being captured by the Milky Way.

R.A. 18h 55m, DEC. -30°29'
MAGNITUDE 8.4
DISTANCE 87,000 light years

Omega Nebula Messier 17

Also known as the Swan Nebula, Messier 17 is best located with binoculars, sweeping down the length of nearby Scutum to the border with Sagittarius looking for a wedge-shaped patch of nebulosity. Through larger telescopes, the nebula takes on a structure similar to the Greek capital Omega (Ω). M17 is one of the brightest and most intense star-forming regions in the Milky Way, and would be a far more spectacular object if it was closer to Earth. As it is, it still offers some rewarding views for stargazers.



R.A. 18h 20m, DEC. -16°11'
MAGNITUDE 6.0
DISTANCE c.5,500 light years



Lagoon Nebula Messier 8

Standing out from the Milky Way under the darkest skies, this cloud of delicately glowing gas in western Sagittarius is one of only two star-forming nebulae visible to naked-eye observers from the northern hemisphere. Binoculars will show a bright nucleus at the heart of a glowing cloud spread across the width of three Full Moons, while small telescopes will begin to reveal some of its detail including the bisecting stream

of dust that gives the nebula its name. A naked-eye star cluster, NGC 6530, overlays the nebula's eastern half and is thought to have emerged in the last 2 million years.

R.A. 18h 04m, DEC. -24°23'
MAGNITUDE 6.0
DISTANCE 5,000 light years

Sagittarius The Galactic Center

High Contrast

This beautiful long-exposure view of the region around Sagittarius and Corvus captures the blaze of light from countless stars in the Milky Way, contrasting with the spine of dust that runs along the Sagittarius/Carina spiral arm. The bright knots of the Lagoon and Trifid nebulae are on the extreme left, while Antares and the Rho Ophiuchi Complex dominate the right-hand side of the image. The small square marks the location of the Sagittarius A* radio source at the center of the Milky Way, 20,000 light years beyond most structures visible in this picture. Invisible radiations like radio and X-rays can see through intervening material to lift the veil on our galaxy's central regions.



R.A. 17h 46m, DEC. -29°00'
MAGNITUDE N/A
DISTANCE 26,000 light years

Multiwavelength Milky Way

This colorful image combines views of the Milky Way's central region taken by three of NASA's "Great Observatories" satellites. Near-infrared light captured by the Hubble Space Telescope is shown in yellow, a deep-infrared view from the Spitzer Space Telescope appears in red, while data from the Chandra X-Ray Observatory is coded blue. Lifting the veil on the heart of our galaxy reveals a landscape of twisted nebulae and dust clouds, shaped by violent stellar winds, supernovae shock waves, and powerful gravitational forces. Sagittarius A*, at the heart of our galaxy, is just to the right of center.



Sagittarius A*

This image from the Chandra X-Ray Observatory is the highest-resolution view of the Milky Way's central region yet obtained. Amid the clouds of reddish lower-energy radiations, lobes of gas emitting powerful X-rays extend on all sides of the Sagittarius A* object. Hubble Space Telescope observations have revealed the presence of clusters of giant stars surrounding Sagittarius A*, orbiting under the influence of an object that contains 4 million solar masses of material in a region of space smaller than the orbit of Uranus. The fact that there is no visible object coinciding with the radio source and the cluster's center of mass is clinching evidence for a supermassive black hole acting as the gravitational "anchor" for our entire galaxy.



Hercules

A large northern constellation represents the great hero of Greek and Roman myth. Earlier Greek astronomers knew it as Engonasin, or "the kneeling one." Despite its size, Hercules lacks in bright stars—its most prominent deep-red objects are globular star clusters, including one of the sky's finest.

It is located by looking midway between the bright stars Vega in Lyra and Rigel in Boötes. Hercules consists of a lopsided quadrangle of stars known as the Keystone, with extended chains of stars at each corner marking the hero's body. He is usually depicted upside down, kneeling with his foot on the head of the dragon Draco, and a club in one hand. In Greek myth, he was famously forced to accomplish 12 tasks to atone for killing his family. The hero's head is represented by the double star Rasalgethi, which is easily resolved through a small telescope to reveal a bright red star of magnitude 4.5 and a greenish-white companion of magnitude 5.4. Delta Herculis is another attractive double for small telescopes, consisting of a blue primary of a magnitude 3.1, with a companion of magnitude 8.2.



AT A GLANCE

NAME Hercules
MEANING Hercules
ABBREVIATION Her
GENITIVE Herculis
R.A. 17h 23m
DEC. +27° 30'
AREA 1,225 (5)
BRIGHTEST STAR Kornephoros (β)

Messier 13

Hercules is home to the finest globular cluster in the northern sky—Messier 13. This huge cluster contains roughly a million stars crammed into a ball just 150 light years across. At a distance of 25,000 light years from Earth, it is just visible to the naked eye, and appears through binoculars as a circular patch of light. Small telescopes can pick out individual chains of stars around its outer edges.



Carina Inside View



Massive Cluster NGC 3603

When British astronomer John Herschel discovered this cluster while working in South Africa in 1834, he at first thought that it might be globular in nature. In reality, however, NGC 3603 is a particularly dense open cluster, perhaps just a million years old and containing the greatest concentration of heavyweight stars known in the Milky Way galaxy. Though the cluster is surrounded by a dense cloud of gas and dust, fierce radiation and strong stellar winds from its stars have cleared out its surroundings to leave it beautifully framed in empty sky.

R.A. 11h 15m, **DEC.** -61°16'
MAGNITUDE 9.1
DISTANCE 20,000 light years



Bullet Cluster 1E-0657-558

In an empty corner of western Carina, powerful telescopes reveal this distant cluster, about 3.7 billion light years from Earth. The Bullet formed during a dramatic collision between galaxy clusters that began around 150 million years ago. This image shows the distribution of mass (blue) and X-ray emitting gas (pink) between the colliding clusters—it reveals that while the clouds of "cluster gas" have collided head-on, both the galaxies and the mysterious "dark matter," which provides much of the cluster's mass, have passed through each other almost unaffected.

R.A. 06h 59m, **DEC.** -55°57'
MAGNITUDE 14.2 and fainter
DISTANCE 3.7 billion light years

Star on the Brink Eta (η) Carinae

A wide view of the Carina Nebula reveals the bulbous "Homunculus Nebula" around Eta Carinae at its heart. One of the most remarkable stars in the sky, Eta currently shines at an unspectacular magnitude 4.6, but is an unpredictable variable: during an outburst that peaked around 1843, it briefly became the second-brightest star in the entire sky. Eta consists of a pair of blue supergiants, each with the mass of around 60 to 80 Suns and pumping out hundreds of thousands of times more energy. Both stars will end their lives as supernovae in the astronomically near future.

R.A. 10h 45m, **DEC.** -59°41'
MAGNITUDE c.4.6 (var)
DISTANCE 7,500 light years

Dorado The Large Magellanic Cloud



Irregular Satellite The Large Magellanic Cloud

(LMC) is the largest of the Milky Way's satellite galaxies, following a 1.5 billion-year orbit shared with the Small Magellanic Cloud (see page 204). With a diameter of 20,000 light years, it resembles an isolated patch of our own galaxy, 20 times the width of the Full Moon, on the border of Dorado and Mensa. The LMC is easily spotted with the naked eye, and binoculars reveal a broad bar of stars that is its major feature—although usually classed as irregular, the LMC shows some structure and is sometimes called a “one-armed spiral.” Telescopes of any size are ideal for exploring its population of nebulae and star clusters.

R.A. 05h 24m, DEC. -69°45'
MAGNITUDE 0.1
DISTANCE 179,000 light years

Starry Vista LH 95

Although dwarfed by the nearby Tarantula Nebula, this star-forming region of the LMC has provided a wealth of information about the way stars form inside this gas- and dust-rich galaxy. Until recently, the nebula was known only from bright and hot blue-white stars, with up to three times the mass of the Sun. In 2006, however, a study using the Hubble Space Telescope revealed more than 2,500 infant stars that have not yet settled down onto the “main sequence” of stellar evolution (the yellow and orange stars in the image below right).

These include red dwarfs with as little as one-third the mass of the Sun.

**R.A. 05h 37m,
DEC. -66°22'**
MAGNITUDE 11.1
**DISTANCE 180,000
light years**



Tarantula Nebula NGC 2070

The Tarantula Nebula is one of the largest star-forming regions in our Local Group of galaxies. Binoculars or a small telescope will show it as a collection of long gaseous tendrils resembling the legs of a gigantic spider. Overall, the complex is around 1,000 light years across—if it was transplanted to the current location of the Orion Nebula M42, it would cover some 30 degrees of the sky and be bright enough to cast shadows. The nebula is thought to owe its size and intensity to its position on the leading edge of the LMC, where it suffers from compression effects as the galaxy moves around its orbit.

**R.A. 05h 39m,
DEC. -69°06'**
MAGNITUDE 8.0
**DISTANCE 180,000
light years**



Superstars R136

Small telescopes are enough to spot the star cluster at the heart of the Tarantula Nebula, but they cannot hint at its awesome scale. This dense ball of heavyweight blue stars is just 1–2 million years old and pumps out intense ultraviolet radiation that excites gas throughout the enormous nebula. At its heart sits a tight knot of stars called R136a, recently separated into individual components that include R136a1, the most massive

star known up to this time. This stellar monster has 265 times the mass of the Sun and 10 million times its luminosity—it is about as big as a star can get before it begins tearing itself apart.

R.A. 05h 39m, DEC. -69°06'
MAGNITUDE 9.5
DISTANCE 180,000 light years

Orion The Orion Nebula M42

Infant Stars

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RA. 05h 35m, DEC. -05°27'
MAGNITUDE 4.0
DISTANCE 1,350 light years



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rather than pink. Larger telescopes only increase the levels of detail visible in this wonderful flower-like structure. As well as M42, Orion's Sword is home to several other interesting nebulae, though none is as bright and large as the so-called Great Nebula.

Virgo The Virgo Cluster

Messier 87

The Virgo Cluster's central giant elliptical galaxy is the closest of its kind to Earth. Through small telescopes it looks somewhat similar to a globular cluster, but in reality it is one of the largest known galaxies. A million million stars jostle in a core that spans roughly 160,000 light years in diameter. Tens of billions more orbit in a halo that stretches out to 250,000 light years from the center. Radio emissions and a visible jet of material shooting from the core show that M87 has an active nucleus—a supermassive black hole feeding on material from its surroundings. Hubble Space Telescope images have revealed the dusty skeleton of a cannibalized galaxy embedded within M87, and this material is probably responsible for the ongoing activity.

R.A. 12h 31m, DEC. +12°24'
MAGNITUDE 8.6
DISTANCE 50 million light years



Messier 58

This barred spiral galaxy, 68 million light years from Earth, lies on the far side of the Virgo Cluster, but is one of its brightest galaxies. Small telescopes can locate its bright nucleus, but may have difficulty distinguishing the galaxy from nearby ellipticals—larger instruments are needed to pick up the light of the spiral arms. This infrared image from the Spitzer Space Telescope distinguishes between relatively sedate, mature stars spread throughout the galaxy's central core, bar, and disc (shown in blue), and gas and dust in star-forming regions concentrated in the spiral arms (shown in red).

R.A. 12h 38m, DEC. +11°49'
MAGNITUDE 9.7
DISTANCE 68 million light years

Central Regions

This mosaic view covers a broad span of the Virgo Cluster with an area equivalent to 12 Full Moons, revealing two clear concentrations of galaxies within. At lower left, dozens of galaxies cluster around the giant elliptical M87, while at upper right, they gather around two smaller ellipticals, M86 and M84. A third concentration, not shown in this image, is focused on another large elliptical called M49. The three groups are in the process of merging together into a single giant cluster—a process that all clusters eventually pass through and which can help astronomers estimate their age.

R.A. 12h 30m, DEC. +08°00'
MAGNITUDE 9.4
DISTANCE 68 million light years

