The Southern Summer

04.00 to 10.00 Hours Right Ascension

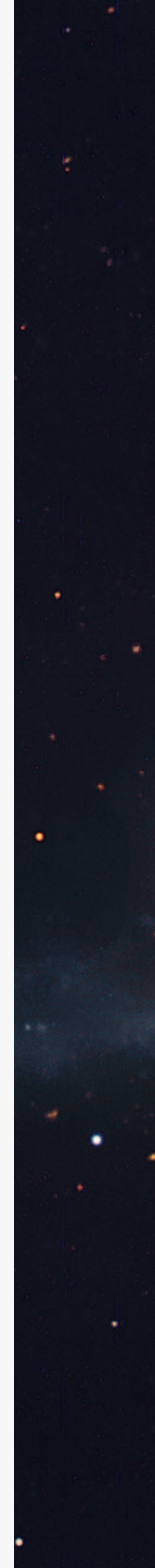
The Southern Summer

This is the time of year of Orion on the celestial equator with a pale ghost of the Milky Way traversing the northern sky. However, south of the celestial equator the warm nights of summer bring both Magellanic Clouds high into the sky. We also see the rich and starry regions in Carina, Puppis, Vela and Pyxis, the remains of the ancient Greek ship Argo Navis, dismantled in the southern Milky Way. This deep image, recorded with a small refractor, reveals the assortment of extraordinary star-forming regions that have emerged from the Orion Molecular Cloud complex. Iconic objects such as the Orion and Horsehead Nebulae are essentially thin blisters of glowing gases over the surface of vast molecular clouds, illuminated by massive stars.

NGC 1531 and NGC 1532

This intriguing pair of interacting galaxies lies about 55 million light-years away in the direction of the constellation of Eridanus (The River). The larger galaxy is NGC 1532, and it is a dusty spiral system rather like the Milky Way, seen almost edge-on. It appears to be interacting with a smaller companion, NGC 1531. This latter is a largely gasless spiral. The interaction is mostly indicated by the anomalous burst of star formation in the nearest spiral arm in NGC 1532 and some curiously displaced emission nebulae that appear to be close to NGC 1531, which seems to be in the background. Less obvious here are large plumes and recently formed clusters of blue stars in the outer arms of NGC 1532. All these features are signatures of the immense tidal forces stirred up as galaxies collide.

We only see a snapshot of this system, so there is no reason to think that this interaction is the first that NGC 1532 has experienced, and it is unlikely to be the last. In orbit around the large spiral are several other dwarf galaxies, visible on wide-angle photographs of the group. They are themselves probably the result of ancient mergers in what is believed to be a hierarchical process that has been building ever-larger galaxies (and reducing the number of smaller ones) since the beginning of time.



NGC 1531 and NGC 1532

The pair of galaxies NGC 1531 and NGC 1532 were imaged with the Danish 1.54-metre Telescope at ESO's La Silla Observatory. The cannbalistic nature of galaxy interactions is evident as the larger spiral is gradually consuming its smaller companion.

NGC 1672

NGC 1672 is another variation on a broad theme that can be summed up as “nearby barred spiral galaxies.” While NGC 1672 has many features in common with the twin prototypes of this class, NGC 1300 and NGC 1365 (p. 202 and 206 respectively), this denizen of Dorado, in the far southern sky, offers some interesting and revealing differences.

The galaxy has two main spiral arms, delineated by well-defined, curved regions of star formation, indicated by red nebulae and patch clumps of stars. These are clearer in the southern (lower left) arm than in its northern counterpart, but on the inner sides of both arms are the dust lanes from which the hot new stars and pink nebulae emerge. However, neither of the outer dust lanes appears to reach the central bulge. Instead, the inner dust lanes seem to arise out of nothing before spiraling into the very luminous nucleus, and at their ends lies a pair of stubby arms with chaotic star clusters and nebulae.

We can offer no authoritative explanation of this, except that on very deep images the outer parts of the galaxy (not seen here) are disturbed in a way that is strongly suggestive of a recent merger or gravitational encounter. The active and very compact active nucleus of the galaxy and the brilliant starburst ring around it strongly hint that the galaxy’s central black hole is being fed, possibly with material deflected by some kind of minor merger or disturbance.

Astronomers believe that barred spirals have a unique mechanism that channels gas from the disk inwards towards the nucleus. This allows the barred portion of the galaxy to serve as an area of new star generation. It appears that the bars are short-lived, begging the questions: Will galaxies without a bar develop one in the future, or have they already hosted one that has disappeared?

NGC 1672

These observations of NGC 1672 were taken with Hubble’s Advanced Camera for Surveys (ACS). This composite image was made from data taken through filters that isolate light from the blue, green, and infrared portions of the spectrum, as well as emission from ionized hydrogen.

LHA 120–N11

The Large Magellanic Cloud contains many bright bubbles of glowing gas. One of the largest and most spectacular has the name LHA 120–N11, and it has much in common with LHA 120–N44 (p. 40). The "N" designation comes from a listing in the catalog compiled by an American astronomer and astronaut, Karl Henize, in 1956, and so LHA 120–N11 is also informally known as N11. The dramatic and colorful features visible in the nebula are the tell-tale signs of star formation, and it is a well-studied region that extends over 1000 light-years. After the Tarantula Nebula (p. 52), which is at the opposite end of the LMC's distinctive bar, it is the second largest star-forming region within the LMC and has produced some of the most massive stars known.

It is the repetitive, self-perpetuating, but erratic process of star formation that gives N11 its distinctive look. Several successive generations of stars, each of which formed further away from the center of the nebula than the last, have created shells of gas and dust, the largest of which contains a substantial star cluster. These shells were blown away from the newborn stars in the turmoil of their energetic birth and early life, creating the ring- and bean-like shapes so prominent in this image.

Other energetic star clusters abound in N11, including NGC 1761 seen at the bottom of the image to the right. Although it is much smaller than the Milky Way, the LMC is a very active star-forming galaxy. Studying these distant stellar nurseries helps astronomers understand a lot more about how stars are born in different environments and how these early events affect their ultimate development and lifespan.

Overview of N11

This image taken with a small amateur telescope reveals the full extent of the star-forming complex N11. The dynamic structures of the complex are shaped by the intense radiation of its progeny of young massive stars.

Hubble Image of N11

This vista of N11 shows the central part of the object and was captured by the NASA/ESA Hubble ACS. This picture is a mosaic of ACS data from five adjacent fields and covers a region about six arcminutes across, whose outline is indicated in the small image above. The star cluster NGC 1761 is seen at lower right.

NGC 1909

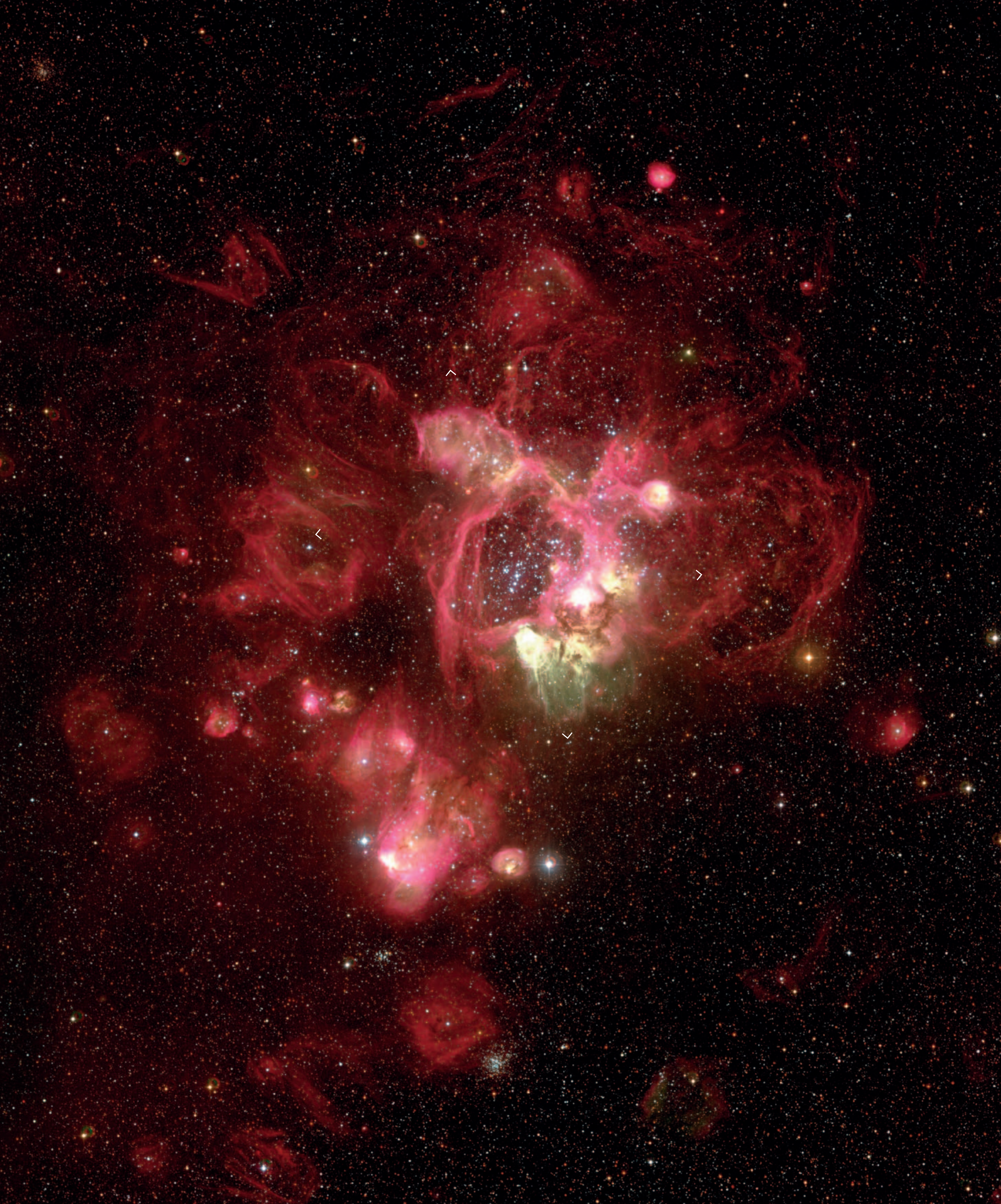
The classic reflection nebula NGC 1909, also known as IC 2118, lies 2 degrees northwest of the bright supergiant star Rigel, the bright star lower left, which is thought to be the main source of illumination for the nebula. The huge glare around the star is produced by the scattering of its plentiful light in Earth's atmosphere and in the telescope. Rigel is truly a big star and is almost 90,000 times as luminous as the Sun. It is about 800 light-years away, and therefore NGC 1909 is at about the same distance. The next brightest star in the picture is Cursa (Beta Eridani), to the north of the nebula. It is only 90 light-years from the Sun, and much too far from the nebula to illuminate it.

NGC 1909 is also known as the Witch Head Nebula, and it certainly has a ghoulish shape, although a more benign interpretation of this scene would have the witch warming her gnarled hands on the glow from Rigel. However, the dust that reflects Rigel's light remains cool inside, except for some signs of star formation that are only detectable deep within the nebula by means of infrared observations. About ten protostars and T-Tauri stars have been found, and these will eventually disperse the cloud from within.

The molecular clouds of NGC 1909 probably lie towards the outer boundaries of the vast Orion-Eridanus bubble, a giant supershell of molecular hydrogen to the west of the Orion OB association and blown by winds from the high mass stars of the Orion OB1 association. To the east of Orion this interaction with the interstellar medium is seen as Barnard's Loop, but here the influence is seen in the shape of the delicate cometary clouds of NGC 1909.

The Witch Head Nebula

This reflection nebula is associated with Rigel, the bright star in Orion's lower right foot. The blue color is caused not only by Rigel's high temperature but also by dust grains scattering blue light more efficiently than red. The same physical process causes Earth's daytime sky to appear blue.



LHA 120–N44

This complex assembly of bubbles, filaments, and bright knots lies in the Large Magellanic Cloud (LMC) and the faintest filaments extend over 1000 light-years. LHA 120–N44, or N44, is a large star-forming region, but not the largest in the LMC. It has given birth to several generations of massive stars and their inevitable supernovae, and it is these stars and their violent ends that have sculpted the nebulosity. The most obvious feature of N44 is an irregular ring, within which is a cluster of about 40 bright stars. These stars are the origin of powerful stellar winds that blow away the surrounding gas, piling it up and creating gigantic interstellar bubbles. Structures of this type are common in the Magellanic Clouds, but rare in the Milky Way.

It is very likely that supernovae have already exploded in N44 during the past few million years, thereby sweeping away the surrounding gas and compressing nearby molecular clouds to continue the star-forming process. This can be seen around the central wind-blown cavity, with smaller bubbles, filaments, and bright, compact emission nebulae scattered throughout, all evidence of young stars.

In the detailed image (below), softly glowing filaments that stream from some of the hot young stars in N44 are seen. The network of nebulous filaments surrounds a rare Wolf–Rayet star. Such stars are characterized by an exceptionally vigorous stellar wind of charged particles, and they are rare because such disruptive behavior cannot be sustained for long. The shock of the wind colliding with the surrounding interstellar medium causes the gas to glow.

N44 Detailed Image
Gemini Legacy Image of LMC superbubble complex N44 as imaged with the Gemini Multi-Object Spectrograph on the Gemini South Telescope in Chile. The picture was made from narrow wavebands of light emitted by oxygen, sulfur, and hydrogen. It is not possible to make a true-color image from this combination.

N44 in the Large Magellanic Cloud
This wide-field image was made with a relatively small, ground-based telescope, the MPG/ESO 2.2-metre Telescope. The green color indicates areas that are particularly hot. The picture was made from three separate exposures made in broadband green and blue light and narrowband H-alpha (red light) from fluorescent hydrogen excited by adjacent hot stars

The Large Magellanic Cloud

Both the LMC and its smaller companion, the Small Magellanic Cloud (SMC), are easily seen with the unaided eye and have always been familiar to people living in the southern hemisphere. The credit for bringing these galaxies to the attention of Europeans is usually given to the Portuguese explorer Fernando de Magellan and his crew, who observed and named them on their 1519 sea voyage. However, the Persian astronomer Abd Al-Rahman Al Sufi and the Italian explorer Amerigo Vespucci recorded their sighting of the Large Magellanic Cloud in AD 964 and AD 1503, respectively.

The Magellanic Clouds are a binary system of dwarf irregular galaxies that orbit our Milky Way and are interacting with it. These nearby galaxies look like detached parts of the Milky Way, and although their optical boundaries are indistinct, the LMC is some 15 000 light-years across, making it the fourth largest member of the Local Group of galaxies, and, at about 160,000 light-years, the third closest galaxy to our own. The most massive Local Group member is the Milky Way itself, followed by Messier 31 and Messier 33.

The origin of the LMC remains uncertain, but its destiny is assured — it will eventually be absorbed by the Milky Way, though at present it seems to be moving away from our galaxy at about 100 kilometers per second.

The Large Magellanic Cloud
The LMC is about one sixth the diameter of the Milky Way and contains about one-tenth its mass. Although it is classified as an irregular galaxy it shows traces of spiral structure and has an off-center, featureless bar of older stars. Sporadic star formation occurs all over the galaxy, but is concentrated towards the eastern end (right), and at its heart — where the spectacular Tarantula Nebula is situated (p. 52). This lopsided concentration of star formation in an otherwise fairly symmetrical galaxy is the result of ongoing gravitational interactions with its companion galaxies, the SMC and the Milky Way. Many interesting objects are visible in the LMC with the brightest and most spectacular described elsewhere in this book.

The Orion Nebula and the Trapezium Cluster

Lying a few degrees south of the celestial equator, and in one of the best-known constellations, the Orion Nebula can be seen from every inhabited part of the world. It is also visible to the unaided eye, as the slight fuzzy central "star" in the sword-hilt of Orion. However, its fame rests on its astonishingly radiant beauty as seen in astronomical images and its scientific importance as one of the nearest, very young star-forming regions in the sky. The nebula itself is a bright condensation of young stars of the Orion Molecular Cloud. The cloud is at a distance of about 1500 light-years; it extends far beyond the Orion Nebula, and includes the equally famous Horsehead Nebula, among others.

Although it is 40 light-years across, the highly luminous, ionized gas of the Orion Nebula, or Messier 42, is a remarkably thin blister on the irregular surface of the thick and dusty molecular cloud, which is illuminated by the newly-formed Trapezium stars. Until recently, these intensely hot stars were embedded in the nebula, and their radiation is burning into the gas and dust from which they so recently emerged. Fortunately, they have blown away the opaque material along our line of sight, but much remains, and the streaks of light and color that give the Orion Nebula its distinctive appearance reveal the course of the stellar winds whipping through it.

The Trapezium stars are all within 1.5 light-years of each other, which is unusually close for neighboring stars, and several are multiple stars. Their combined light is about 250,000 times that of the Sun. By far the most luminous of the Trapezium stars is known as Theta-1, which provides most of the ultraviolet energy. Theta-1C is an enormous star of 40 solar masses and a surface temperature of 40,000 degrees C. If Earth were located within the Trapezium Cluster the night sky would be dominated by extraordinarily bright stars. But that would be the least noticeable effect — if Earth were there it would be rapidly vaporized.

The enormous brightness range of the nebula, from the highly luminous center to the feeble reflections at the periphery, have long been a serious challenge for astrophotographers — the Orion Nebula was the first nebula to be photographed, in 1882.

The Mighty Orion Nebula

This is a wide-field infrared image of the Orion Nebula made with the VISTA infrared survey telescope at ESO's Paranal Observatory in Chile. The picture is composed from images taken through Z, J and Ks filters in the near-infrared part of the spectrum. The total exposure was about 30 minutes, and the image covers a region of sky about 1 degree by 1.5 degrees.