MESSIER 33, THE TRIANGULUM GALAXY

The Triangulum Galaxy is a spiral galaxy approximately 3 million light-years from Earth in the constellation Triangulum. It is catalogued as Messier 33 or NGC 598. **The Triangulum Galaxy is the third-largest member of the Local Group of galaxies, behind the Milky Way and the Andromeda Galaxy. It is one of the most distant permanent objects that can be viewed with the naked eye.**

The galaxy is the smallest spiral galaxy in the Local Group and it is believed to be a satellite of the Andromeda Galaxy due to their interactions, velocities, and proximity to one another in the night sky.

OBSERVATION DATA (J2000 EPOCH)
Right ascension 01h 33m 50.02s
Declination +30° 39' 36.7"
Redshift -0.000607 ± 0.000010
Helio radial velocity -179 ± 3 km/s
Galactocentric velocity -44 ± 6 km/s
Distance 2.38 to 3.07 Mly (730 to 940 kpc)
Apparent magnitude (V) 5.72
CHARACTERISTICS
Type SA(s)cd, Mass 5×10^{10} M$_\odot$
Number of stars 40 billion (4×10^{10})
Size ~60,000 ly (diameter)
Apparent size (V) 70.8 × 41.7 moa
Other designations NGC 0598, MCG+05-04-069, UGC 1117, PGC 5818

Triangulum (M33; lower left of centre) and Andromeda Galaxy (M31; above centre)

ETYMOLOGY

The galaxy gets its name from the constellation Triangulum, which is where it can be spotted. The Triangulum Galaxy is sometimes informally referred to as the "Pinwheel Galaxy" by some amateur astronomy references and in some public outreach websites.

Under exceptionally good viewing conditions with no light pollution, the Triangulum Galaxy can be seen with the naked eye. It is one of the most distant permanent objects that can be viewed without the aid of a telescope. Being a diffuse object, its visibility is strongly affected by small amounts of light pollution. It ranges from easily visible by direct vision in dark skies to a difficult averted vision object in rural or suburban skies.

The Triangulum Galaxy was probably discovered by the Italian astronomer **Giovanni Battista Hodierna** before 1654. In his work "About the systematics of the cometary orbit, and about the admirable objects of the sky", he listed it as a cloud-like nebulosity or obscuration and gave the cryptic description, "near the Triangle hinc inde". This is in reference to the constellation of Triangulum as a pair of triangles.

The galaxy was independently discovered by **Charles Messier** on the night of August 25–26, 1764. It was published in his Catalogue of Nebulae and Star Clusters (1771) as object number 33; hence the name M33. When **William Herschel** compiled his extensive catalogue of nebulae, he was careful not to include most of the objects identified by Messier. However, M33 was an exception and he catalogued this object on September 11, 1784, as H V-17.

Herschel also catalogued the Triangulum Galaxy's brightest and largest H II region (diffuse emission nebula containing ionized hydrogen) as H III.150 separately from the galaxy itself; the nebula eventually obtained NGC number 604. As seen from Earth, NGC 604 is located northeast of the galaxy's central core. It is one of the largest H II regions known, with a diameter of nearly 1500 light-years and a spectrum similar to that of the Orion Nebula. Herschel also noted three other smaller H II regions (NGC 588, 592, and 595). It was among the first "spiral nebulae" identified as such by **Lord Rosse** in 1850.
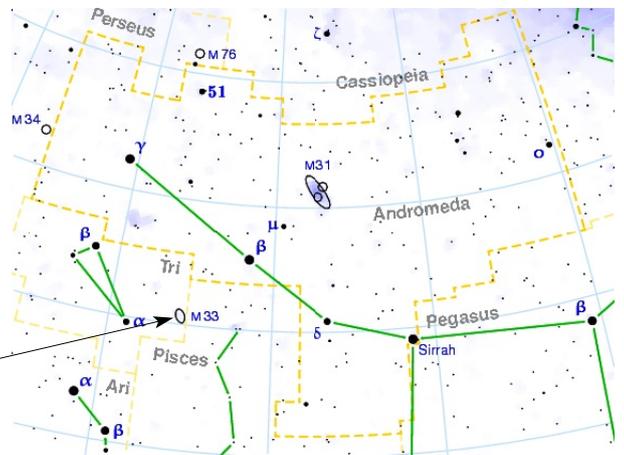
NGC 604 in the Triangulum Galaxy

In 1922–23, **John Charles Duncan and Max Wolf** discovered variable stars in the nebulae. **Edwin Hubble showed in 1926 that 35 of these stars were classical Cepheids, thereby allowing him to estimate their distances. The results were consistent with the concept of spiral nebulae being independent galactic systems of gas and dust, rather than just nebulae in the Milky Way.**

In 2006, a group of astronomers announced the discovery of an eclipsing binary star in the Triangulum Galaxy. By studying the eclipses of the stars, astronomers were able to measure their sizes. Knowing the sizes and temperatures of the stars they were able to measure the absolute magnitude of the stars. When the visual and absolute magnitudes are known, the distance to the star can be measured. The stars lie at the distance of $3,070 \times 10^3 \pm 240 \times 10^3$ ly. The average of 102 distance estimates published since 1987 gives a distance modulus of 2,878,000 light-years.

The Triangulum galaxy is a source of H_2O maser emission. In 2005, using observations of two water masers on opposite sides of Triangulum via the VLBA, researchers were, for the first time, able to estimate the angular rotation and proper motion of Triangulum. A velocity of 190 ± 60 km/s relative to the Milky Way was computed, which means Triangulum is moving towards Andromeda Galaxy and suggesting it may be a satellite of the larger galaxy (depending on their relative distances and margins of error). In 2004, evidence was announced of a clumpy stream of hydrogen gas linking the Andromeda Galaxy with Triangulum, suggesting that the two may have tidally interacted in the past. This discovery was confirmed in 2011. A distance of less than 300 kiloparsecs between the two supports this hypothesis.

The Pisces Dwarf (LGS 3), one of the small Local Group member galaxies, is located $2,022 \times 10^3$ ly from the Sun. It is 20° from the Andromeda Galaxy and 11° from Triangulum. As LGS 3 lies at a distance of 913×10^3 ly from both galaxies, it could be a satellite galaxy of either Andromeda or Triangulum. LGS 3 has a core radius of 483 ly and 2.6×10^7 solar masses.
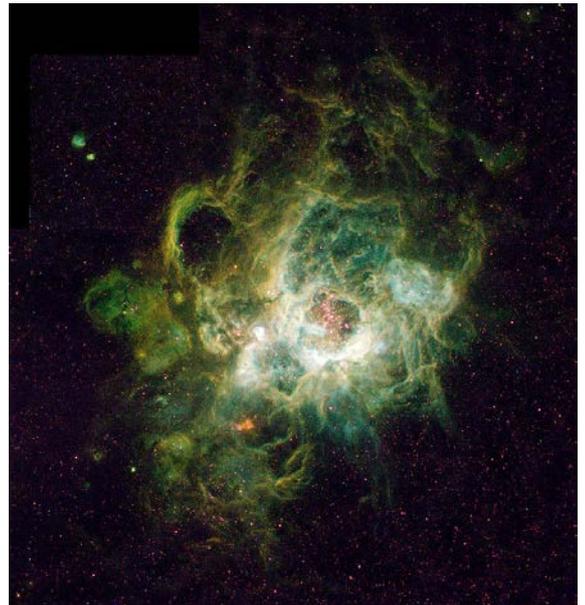
In the French astronomer **Gérard de Vaucouleurs'** revised Hubble Sandage (VRHS) system of galaxy morphological classification, the Triangulum galaxy is classified as type SA(s)cd. The S prefix indicates that it is a disk-shaped galaxy with prominent arms of gas and dust that spiral out from the nucleus—what is commonly known as a spiral galaxy. The A is assigned when the galactic nucleus lacks a bar-shaped structure, in contrast to SB class barred spiral galaxies. American astronomer **Allan Sandage's** "(s)" notation is used when the spiral arms emerge directly from the nucleus or central bar, rather than from an inner ring as

NGC 604, a star-forming region in the Triangulum Galaxy, as imaged by the Hubble Space Telescope

with an (r)-type galaxy. Finally, the cd suffix represents a stage along the spiral sequence that describes the openness of the arms. A rating of cd indicates relatively loosely wound arms.

This galaxy has an inclination of 54° to the line of sight from the Earth, allowing the structure to be examined without significant obstruction by gas and dust. The disk of the Triangulum galaxy appears warped out to a radius of about 8 kpc. There may be a halo surrounding the galaxy, but there is no bulge at the nucleus. This is an isolated galaxy and there are no indications of recent mergers or interactions with other galaxies, and it lacks the dwarf spheroidals or tidal tails associated with the Milky Way.

Star formation is taking place at a rate that is strongly correlated with the local gas density, and the rate per unit area is higher than in the neighbouring Andromeda Galaxy. The total integrated rate of star formation in the Triangulum galaxy is about 0.45 ± 0.1 solar masses per year. It is uncertain whether this net rate is currently decreasing or remaining constant.

The estimated rate of supernova explosions in the Triangulum Galaxy is 0.06 Type Ia and 0.62 Type Ib/Type II per century. This is equivalent to a supernova explosion every 147 years, on average. As of 2008, a total of 100 supernova remnants have been identified in the Triangulum Galaxy.

In 2007, a black hole about 15.7 times the mass of the Sun was detected in this galaxy using data from the Chandra X-ray Observatory. The black hole, named M33 X-7, orbits a companion star which it eclipses every 3.5 days. It is the largest stellar mass black hole known. AK, with Wikipedia Notes