SUPERNOVA

A supernova is an astronomical event that occurs during the last stellar evolutionary stages of a massive star's life, whose dramatic and catastrophic destruction is marked by one final titanic explosion. **This causes the sudden appearance of a "new" bright star, before slowly fading from sight over several weeks or months**.

SN 1994D (bright spot on the lower left), a Type Ia supernova out-shining its home galaxy NGC 4526

Supernovae are more energetic than novae. In Latin, nova means "new", referring astronomically to what appears to be a temporary new bright star. Adding the prefix "super-" distinguishes supernovae from ordinary novae, which are far less luminous. The word supernova was coined by Walter Baade and Fritz Zwicky in 1931.

Only three Milky Way naked-eye supernova events have been observed during the last thousand years, though many have been seen in other galaxies using telescopes. **The most recent directly observed supernova in the Milky Way was Kepler's Supernova in 1604, but the remnants of two more recent supernovae have also been found.** Statistical observations of supernovae in other galaxies suggest they occur on average about three times every century in the Milky Way, and that any such galactic supernova would almost certainly be observable with modern astronomical telescopes.

Supernovae may expel much, if not all, of the material away from a star, at velocities up to 30,000 km/s or 10% of the speed of light. This drives an expanding and fast-moving shock wave into the surrounding interstellar medium, and in turn, sweeping up an expanding shell of gas and dust, which is observed as a supernova remnant. Supernovae create, fuse and eject the bulk of the chemical elements produced by nucleosynthesis. Supernovae play a significant role in enriching the interstellar medium with the heavier atomic mass chemical elements. Furthermore, the expanding shock waves from supernovae can trigger the formation of new stars. Supernova remnants are expected to accelerate a large fraction of galactic primary cosmic rays, but direct evidence for cosmic ray production was found only in a few of them so far. They are also potentially strong galactic sources of gravitational waves.

Theoretical studies indicate that most supernovae are triggered by one of two basic mechanisms: the sudden re-ignition of nuclear fusion in a degenerate star or the sudden gravitational collapse of a massive star's core. In the first instance, a degenerate white dwarf may accumulate sufficient material from a binary companion, either through accretion or via a merger, to raise its core temperature enough to trigger runaway nuclear fusion, completely disrupting the star. In the second case, the core of a massive star may undergo sudden gravitational collapse, releasing gravitational potential energy as a supernova. While some observed supernovae are more complex than these two simplified theories, the astrophysical collapse mechanics have been established and accepted by most astronomers for some time now.

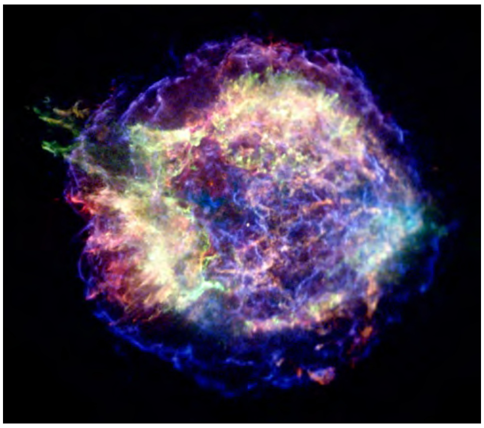
Due to the wide range of astrophysical consequences of these events, astronomers now deem supernovae research, across the fields of stellar and galactic evolution, as an especially important area for investigation.

NAMING CONVENTION

Supernova discoveries are reported to the International Astronomical Union's Central Bureau for Astronomical Telegrams, which sends out a circular with the name it assigns to that supernova. The name is the marker SN followed by the year of discovery, suffixed with a one or two-letter designation. The first 26 supernovae of the year are designated with a capital letter from A to Z. Afterward pairs of lower-case letters are used: aa, ab, and so on. Hence, for example, SN 2003C designates the third supernova reported in the year 2003. The last supernova of 2005 was SN 2005nc, indicating that it was the 367th supernova found in 2005. Since 2000, professional and amateur astronomers have been finding several hundreds of supernovae each year (572 in 2007, 261 in 2008, 390 in 2009; 231 in 2013).

Historical supernovae are known simply by the year they occurred: SN 185, SN 1006, SN 1054, SN 1572 (called Tycho's Nova) and SN 1604 (Kepler's Star). Since 1885 the additional letter notation has been used, even if there was only one supernova discovered that year.

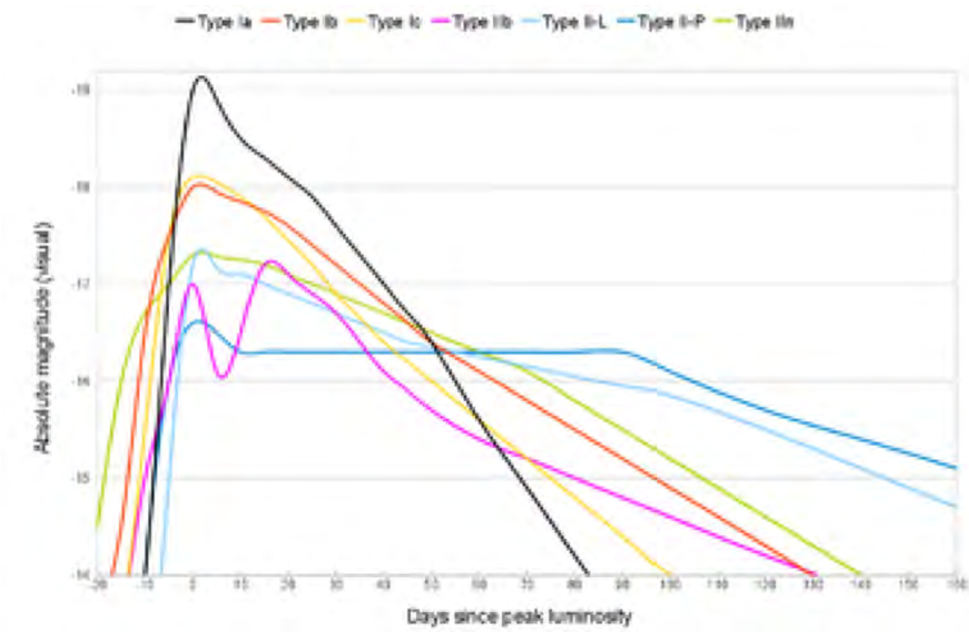
Supernova Type



This Chandra X-ray photograph shows Cassiopeia A (Cas A, for short), the youngest supernova remnant in the Milky Way.

A Type I Supernova results when an ordinary star accumulates matter from a nearby neighbour until a runaway nuclear reaction ignites.
A Type II Supernova results when a large star runs out of nuclear fuel and collapses under its own gravity.
As part of the attempt to understand supernovae, astronomers have further classified them according to their light curves and the absorption lines of different chemical elements that appear in their spectra. The first element for division is the presence or absence of a line caused by hydrogen. If a supernova's spectrum contains lines of hydrogen (known as the Balmer series in the visual portion of the spectrum) it is classified Type II; otherwise it is Type I. In each type there are subdivisions according to the presence of lines from other elements or the shape of the light curve.
Fritz Zwicky in his time defined additional supernovae types, based on a few examples that did not cleanly fit the parameters for a Type I or Type II supernova. Type III supernova is noted for its broad light curve maximum and broad hydrogen Balmer lines. Type IV Supernova has a light curve with hydrogen absorption lines but weak hydrogen emission lines. Type V Supernova is unusual faint with a slow rise to brightness, a maximum lasting many months, and an unusual emission spectrum. These definitions are not in general use anymore and would now all be treated as peculiar Type II supernovae, of which many more examples have been discovered.

Light curves



Comparative supernova type light curves

A historic puzzle concerned the source of energy that can maintain the optical supernova glow for months. The ejecta gases would dim quickly without some energy input to keep it hot. The intensely radioactive nature of the ejecta gases was first calculated in the late 1960s. It was not until SN 1987A that direct observation of gamma-ray lines unambiguously identified the major radioactive nuclei.
The radioactive decay of 56Ni through its daughters 56Co to 56Fe produces gamma-ray photons, and thus the luminosity of the ejecta at for several weeks. Energy for the later light curve fit very closely with the 77.3 day half-life of 56Co decaying to 56Fe. The light curves for Type II supernovae are characterised by a much slower decline than Type I, on the order of 0.05 magnitudes per day. Their visual light output is dominated by kinetic energy rather than radioactive decay for several months, due to the existence of hydrogen in the atmosphere of the supergiant progenitor star. In the initial destruction this hydrogen becomes heated and ionised.
A large numbers of supernovae have now been catalogued and classified to provide distance candles and test models. Average characteristics vary somewhat with distance and type of host galaxy, but can broadly be specified for each supernova type.
Supernovae are thought to be potentially fatal for us if they occur within 26 light years of Earth. They would destroy Earth’s protective radiation shield and expose us to cosmic rays. Because these supernovae arise from common white stars in binary systems, it is likely that such a supernova will occur unpredictably. The closest presently known candidate is IK Pegasi, at 150 Light Years.

AK, with EarthSky and Wikipedia Notes