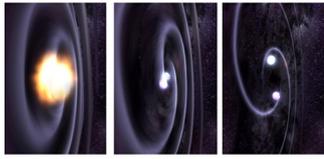


In 1885 an apparently 'new star', or 'nova', was found in the Andromeda nebula. It was just below the limit of visibility to the naked eye. From the mid-1920s onwards, it gradually became clear that some 'nebulae' are in fact galaxies, external to our Milky Way (see tulip 15). The Andromeda galaxy thus became the Andromeda galaxy, located more than two million light-years away. As a result, the luminosity of the 1885 nova was re-evaluated to be nearly a billion times that of the Sun! Astronomers Fritz Zwicky and Walter Baade then coined the term 'supernova' to describe these extraordinary objects. Using the newly commissioned Mount Wilson telescope, they promptly observed several other supernovae. Today, several hundred supernovae are discovered each year, some at distances exceeding one billion light-years!

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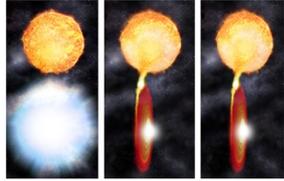


12

Credit: ESA/ESA/D. Berry

Two white dwarfs in a binary system gradually approach each other until they collide, which causes the explosion.

Credit: NASA/CXC/M. Weiss



Two scenarios leading to the explosion of a Type I supernova:

A white dwarf accumulates matter from a companion star.

The mass transfer takes place via an 'accretion disk'. The explosion occurs when the white dwarf approaches the critical mass of 1.4 solar masses. It then explodes as a supernova.



The Mount Wilson

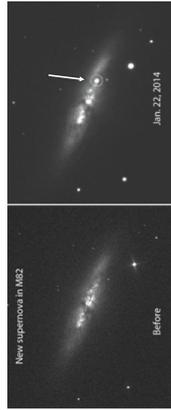
telescope was commissioned in 1917. At the time, it was the largest telescope in the world, with its 2.5 m diameter mirror.



Fritz Zwicky



Walter Baade



A supernova that appeared in the galaxy M82.

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## How do SN Ia explode?

The SN Ia mechanism is completely different from that of SN IIs, although the critical mass of 1.4 solar masses again plays an important role. The star that explodes is a 'white dwarf', the residue from the evolution of a star of a few solar masses. It is made of carbon and oxygen and is 'degenerate', like the iron core of massive stars, but its mass is less than 1.4 solar masses.

However, in a binary system, the mass of the white dwarf can increase by 'accretion' from a companion or by coalescence with another white dwarf. It then contracts and heats up. New nuclear reactions can thus start in its center and ignite the entire star. A combustion front propagates outwards and transforms carbon and oxygen first into nickel, cobalt and iron, then into silicon and magnesium. The white dwarf is destroyed and its matter dispersed.

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## Which stars explode?

A first indication about the nature of stars that explode as supernovae comes from the type of galaxies in which they are found.

SN IIs are always seen in galaxies that are forming stars (spiral or irregular galaxies) but never in galaxies where star-formation has ended for billions of years (elliptical galaxies). This leads to the idea that SN IIs correspond to the explosion of massive stars, whose lifespan is only a few million years.

SN Is, on the other hand, are observed in all types of galaxies, including elliptical ones. This suggests that they arise from low-mass stars, which can explode billions of years after they were formed.

The explosion mechanisms of the two types of supernovae are very different. They are very complex and are actively studied.

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### QUIZ

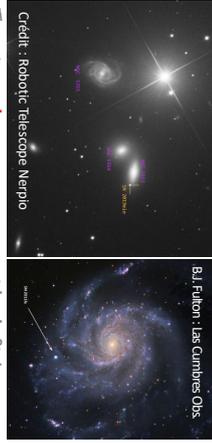
1) Here is a series of spectra of supernova 1992H at different times after maximum brightness. Was it type I or type II?

2) Here are three supernovae observed simultaneously (in January 2022) in the same spiral galaxy! Were there really three explosions so close in time?

3) When will the next supernova visible to the naked eye occur in our galaxy, the Milky Way?

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Credit : Robotic Telescope Nericio  
Two Type I supernovae: on the left in an elliptical galaxy; on the right in the spiral galaxy M101.



Credit : David Mathews



Credit : David Whittall

Two Type II supernovae in nearby spiral galaxies: on the left in the Hunting Dogs galaxy M51; on the right, again in M101. In M101, the type I supernova was observed in 2011 and the type II supernova in 2023.

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