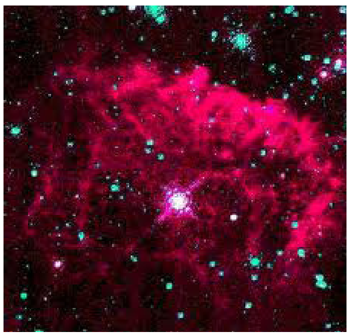
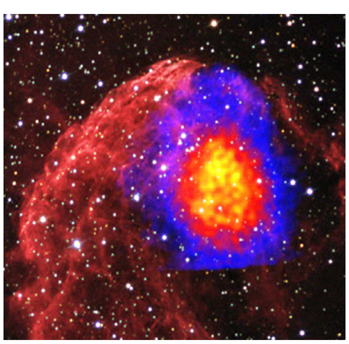
Supernova

The Death of a star.



A supernova is the death of a star. They are extremely bright events and cause a burst of radiation that often briefly outshines an entire galaxy, before fading from view over several weeks or months. During this short interval, a supernova can radiate as much energy as the Sun could emit over its life span.

Supernovae are very rare in our galaxy, occurring once every 50 years. So far, supernovae have only been in distant galaxies. The last supernova noted to take place in the Milky Way (our galaxy) was in 1604. In 1987 a supernova occurred in the outskirts of the Tarantula Nebula in the Large Magellanic Cloud and was close enough that it was visible to the naked eye. It was the closest observed supernova since SN 1604. As the first supernova discovered since 1987, it was labeled “1987A” and was the first opportunity for modern astronomers to see a supernova up close.



The supernova process is caused by the exhaustion of nuclear “fuel” (lighter elements) within the star, so that the reactions are no longer able to resist the gravity trying to compress the solar mass into the core. The star collapses, causing the outer layers to explode outward as gases and dust.

The neutrino signal emerges from the core of a star promptly after core collapse, whereas the light signal may take hours or days to emerge from the stellar envelope. The neutrino signal can therefore give information about the very early stages of core collapse, which is inaccessible to other kinds of astronomy. In fact, an optical supernova display may never be seen at all for a given core collapse: some collapsing stars may never blow up into supernovae, or the star may live in an obscured region of the galaxy.

New elements are created by adding protons and neutrons to hydrogen atoms within the nuclear reactor of a star, producing increasingly heavier elements, up to iron. This process is called nucleosynthesis. Elements heavier than iron (like gold and platinum) are formed in the stellar explosion of a supernova.

Neutrinos are intimately connected to supernovae. During the bulk of a star’s life, about 99% of the energy produced is in the form of light and about 1% as neutrinos. At the end of that star’s life, almost all of the energy produced is in the form of neutrinos.

It is now thought that neutrinos are an important part of the explosion mechanism for supernovae and in the production of heavy elements created during the explosion. Neutrinos also have an important feature in that they escape the exploding star before the light emerges. So detecting a burst of neutrinos from a supernova would allow optical astronomers to study the "turn on" of the supernova long before it would normally be observed.

There exists a network of neutrino detectors around the world that belong to SNEWS (Supernova Early Warning System) and, in the event that a burst of neutrinos is detected, SNEWS will alert the astronomy community (and the amateur astronomer community as well). During its operation, the now decommissioning SNO experiment was a participant in SNEWS. Future experiments at SNOLAB that can detect supernovae are SNO+ and HALO (which would be a dedicated supernovae detector).

HALO – Helium and Lead Observatory used to detect supernovae. The observation of a galactic core-collapse supernova by a Lead-based neutrino detector, as a complement to other neutrino detectors, would provide a wealth of data for both particle physicists and astrophysicists. HALO will be constructed from 80 tons of lead from the decommissioning of the Deep River Cosmic Ray Station and will also use neutron detectors that were originally part of the SNO experiment.

SNO+ – Even though we are replacing heavy water used in the SNO experiment with liquid scintillator for the SNO+ experiment, it can still be used to conduct a supernova search and be part of the SNEWS (Supernova Early Warning System) Network, just like SNO.

SNOLAB

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