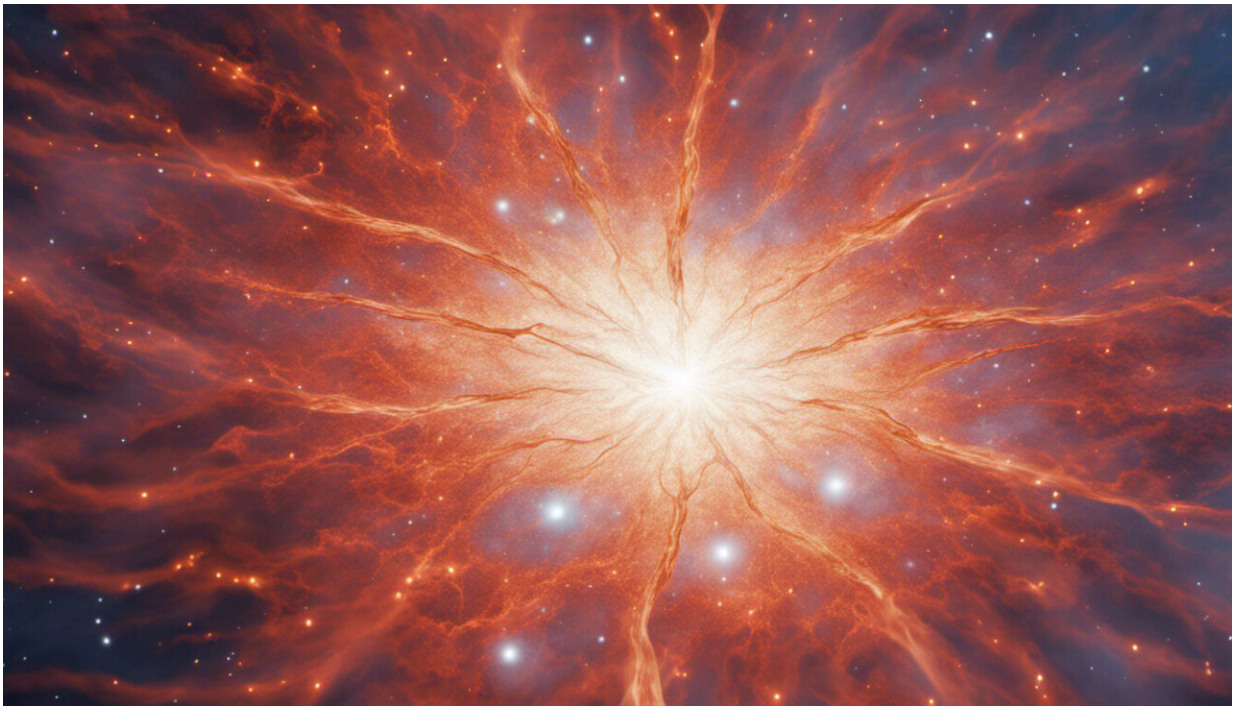
Supernovae death reveals link to stars' birth

September 22 2017



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It was previously thought that molecules and dust would be completely obliterated by the tremendous explosions of supernovae. Yet, for the first time, scientists have discovered that this is not actually the case.

A group of scientists, including those funded under the European Research Council (ERC) financed projects SNDUST and COSMICDUST, have identified two previously undetected molecules;

formylium (HCO+) and sulphur monoxide (SO), found in the cooling aftermath of Supernova 1987A. Having originally exploded in February 1987, Supernova 1987A is located 163,000 light years away in the Large Magellanic Cloud a satellite galaxy of our own Milky Way galaxy.

The dust factory of a very young supernova remnant

The lead author of the study published in the journal *Monthly Notices of the Royal Astronomical Society*, Dr. Mikako Matsuura, from Cardiff University's School of Physics and Astronomy said, 'This is the first time that we've found these species of molecules within supernovae, which questions our long held assumptions that these explosions destroy all molecules and dust that are present within a star.' Accompanying these newly identified molecules were compounds such as carbon monoxide (CO) and silicon oxide (SiO) which had already previously been detected.

Finding these unexpected molecules opens up the possibility that the explosive death of stars creates clouds of leftover gas which cool down to below 200°C, resulting in the various synthesised heavy elements starting to harbour molecules, creating what has been dubbed a 'dust factory'. As Dr. Matsuura goes on to explain, 'What is most surprising is that this factory of rich molecules is usually found in conditions where stars are born. The deaths of massive stars may therefore lead to the birth of a new generation.'

As new stars are created from the heavier elements scattered during explosions, this work opens up the prospect of better understanding the composition of these nascent stars by analysing their source.

A spectacular celestial farewell

The mechanics of supernovae are relatively well understood. When massive stars come to the end of their stellar evolution, they essentially run out of fuel, with not enough heat and energy remaining to counteract the force of their own gravity. Consequently, the outer regions of the star crash down on the core with formidable force, triggering the spectacular explosion and leaving what looks to be a new bright star behind, before it fades away.

Ever since its discovery over 30 years ago, astronomers have faced hurdles in the quest to study Supernova 1987A, especially when it comes to investigating its innermost core. This research was conducted using the Atacama Large Millimeter/submillimeter Array (ALMA) which enabled the team to explore in remarkable detail. As the facility with its 66 antennae is able to observe wavelengths in the millimetres – situated between infrared and radio light in the electromagnetic spectrum – it can penetrate the dust and gas clouds of the supernova. This ability enabled it to expose the newly formed molecules.

To expand on their current findings, the team are planning to continue using ALMA to ascertain the prevalence of HCO+ and SO molecules, as well as further explore for hitherto undetected molecules.

More information: Project website: www.sndust.org/

M. Matsuura et al. ALMA spectral survey of Supernova 1987A – molecular inventory, chemistry, dynamics and explosive nucleosynthesis, *Monthly Notices of the Royal Astronomical Society* (2017). DOI: 10.1093/mnras/stx830

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