

Magnetar-powered supernova

As a dying star's iron core shrinks to some 20 km in diameter and its spin increases by a factor of 10 000, it collapses in a supernova and forms a neutron star. Before the neutron star reaches its solid equilibrium state, the stellar material acts as a dense dynamo powered by superconducting, spinning, and convective fluid. If the spin speed is faster than the convection, the magnetic field strength can reach 10^{14} – 10^{15} gauss—the strongest yet found in the universe—and the neutron star is then classified as a magnetar (see *PHYSICS TODAY*, May 2005, page 19). When a magnetar forms, a fraction of its spin energy can be emitted later as optical radiation and produce what's known as a superluminous supernova.

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and Astrophysics in Taipei, Taiwan, and his colleagues recently published results of a three-dimensional hydrodynamical simulation of a superluminous supernova. This snapshot image from their model shows a magnetar in the center; each color corresponds to a material of different density. The magnetar's radiation energizes both a hot bubble of fluid around the magnetar and an outward explosive shock. Those two instabilities produce substantial turbulent mixing, which is apparent in the image. Compared with 1D models, the researchers' 3D model better matches the light curves and spectra observed from such supernovae. (K.-J. Chen, S. E. Woosley, D. J. Whalen, *Astrophys. J.* **893**, 99, 2020.)

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