The electron-capture origin of supernova 2018zd

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In the transitional mass range ($\sim$ 8–10 $M_\odot$) between white dwarf formation and iron core-collapse supernovae, stars are expected to produce an electron-capture supernova. Theoretically, these progenitors are thought to be super-asymptotic giant branch stars with a degenerate O+Ne+Mg core, and electron capture onto Ne and Mg nuclei should initiate core collapse. However, no supernovae have unequivocally been identified from an electron-capture origin, partly because of uncertainty in theoretical predictions. In this talk, I will present six indicators of electron-capture supernovae and show that supernova 2018zd is the only known supernova having strong evidence for or consistent with all six: progenitor identification, circumstellar material, chemical composition, explosion energy, light curve, and nucleosynthesis. For supernova 2018zd, we infer a super-asymptotic giant branch progenitor based on the faint candidate in the pre-explosion images and the chemically-enriched circumstellar material revealed by the early ultraviolet colours and flash spectroscopy. The light-curve morphology and nebular emission lines can be explained by the low explosion energy and neutron-rich nucleosynthesis produced in an electron-capture supernova. This identification provides insights into the complex stellar evolution, supernova physics, cosmic nucleosynthesis, and remnant populations in the transitional mass range.