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Summary of JD 9 *Supernovae*: past, present, and future

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SN 1006 was the first (and for a very long time the only) event to be caught before peak light. A passage which, according to Stephenson, does not actually pertain to the SN, nevertheless makes clear that, even then, a hypothesis was more likely to be accepted if it made a prediction later verified, though the prediction was that something bad would happen to Emperor Sanjo In. The hypothesis was that the star was not new, but related to behavior of existing stars in Qichen Jianjun. According to the poster by P.J. Boner, Kepler made the opposite choice for 'his' SN, calling it a genuinely new star formed out of the ether, rather than mere change in appearance. Indeed the distinction between true novae and variable stars was not drawn correctly until Hevelius's 1662 study of Mira, after Tycho had shown that his event (and the comet of 1577) were more distant than our Moon, a point disputed by many of his contemporaries, but accepted by Galileo, who applied a very early statistical method to many different observations of SN 1572. Tycho's main advantages were better equipment and hard work, again not so different from present conditions.

The next 'golden moment' was perhaps the recording of the Crab nebula (Bevis 1731), followed by its cataloguing as M 1 (1758) and its naming by Rosse (1844). Handing over to the theorists, we find Milne attributing novae to stars collapsing to white dwarfs, and Pickering and Seelinger blaming collisions with a planet or another star (for the brightest events) in the 1920s. That decade also saw Lundmark's identification of the Crab with the 1054 event, along with his and Curtis's conclusion that there were likely to be two sorts of novae, the second, brighter, class including S And (SN 1885) with peak M_V near -15 (on an old distance scale). Baade and Zwicky, with core collapse, neutron stars, and cosmic rays, belong to the 1930s, along with Humason & Baade's recognition of Balmer lines in SNe 1926a and 1936a (both indeed probably Type IIs), and the suggestion from Olin C. Wilson and Zwicky (separately!) that supernovae could serve as better beacons for cosmological studies than whole galaxies. To the 1940s belong Minkowski's distinction of Types I and II (only the latter showing H features) and the beginning of radio astronomical searches and discoveries of SNRs. X-ray,γ-ray, and pulsar identifications began in the 1960s.

Turning again to the theorists, we find B^2FH on nucleosynthesis, also pointing out in 1957 the need for continuing energy input to SN light curves. Truran picked out the right nucleus for this (Ni-56) in 1969, after Hoyle and Fowler had put forward nuclear explosions as an alternative energy source to core collapse in 1960. The idea that binaries with accretion onto white dwarfs were a very good bet was 'in the air' in the early 1970s, the first published paper I've found coming from Wheeler & Hansen in 1971. That it appeared in a non-prestigious journal (*Ap&SS*) probably means something.

February 23, 1987 was a *very* good day for core-collapse events, and whoever figured out that Types' Ib and Ic belong to that group, but with progenitors stripped of their

hydrogen was, I think, exceedingly clever. He also broke the old anti-degeneracy of Type I's happening in Population II and Type II's happening in Population I.

Going into Joint Discussion 09, I had a list of eight wishes and questions:
(*a*) good statistics on rates and hosts and distributions in hosts;
(*b*) identification of the correct progenitors (private prejudice in favor of WDX2);
(*c*) possible ignition triggers apart from reaching $M_{\rm Ch}$;
(*d*) identification of the explosion mechanism(s);
(*e*) a good balance sheet for nucleosynthesis, in which the amount of Ni-56 calculated would equal the amount of Fe-56 seen later (not to mention the various other elements fed into chemical evolution by SNe Ia);
(*f*) ways of describing the interactions of ejecta with interstellar and circumstellar matter, including that shed by a donor companion (if there is one);
(*g*) contribution of nuclear events to acceleration of cosmic rays, heating and stirring of the ISM, and various other kinds of feedback in early and late star formation; and
(*h*) certainty that the candles could be at least standardized for cosmological application.

And I came out with more or less the same list of wishes and questions, plus the cold comfort that they are the same ones worrying every one else.

A few personal thoughts:
(*i*) very possibly there is more than one progenitor type and more than one explosion mechanism represented in the events we see;
(*ii*) in light of Alan Title's remarks in his Invited Discourse about solar X-ray spectroscopy, the task of measuring Fe or anything else in SNRs seems more daunting than ever;
(*iii*) if M_2 survives, find it!
(*iv*) what produces the magnetic fields in Type Ia remnants (Gerardy talk); and
(*v*) theorists are cheap, while telescopes are expensive.

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