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223rd American Astronomical Society Meeting

Session #354 — Supernovae Poster Session

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Presentation #354.13 — The Metrology of Supernova Light Curves

Abstract:

We model the Type Ia supernova light curve as the superposition of three luminosity pulses -- an initial pulse generated by the deposition of Ni-56 followed by the subsequent pulses generated by the radioactive decays Ni-56 → Co-56 → Fe-56. We assume that the two radioactive decays occur in a stable environment with density and temperature so high that the two decay rates are accelerated by the same factor. We use a three parameter Weibull probability density function to model the Ni-56 deposition so that the model can be written as a linear combination of the solutions to 2 coupled ordinary differential equations with 4 adjustable nonlinear parameters specifying the time of the onset of Ni-deposition, the shape and the scale of the deposition pulse, and the acceleration factor for the two decay rates. The two linear parameters specify the energies associated with the three processes and enables the estimation of the energy/nucleon emitted by the Ni-deposition. Fitting the model to the measured light curves for a sample of relatively nearby supernova gave fits that explained more than 99% of the total variance in every case. Such high fidelity to the measured data indicates that the fitted light curves may give more precise estimates of important parameters like the maximum luminosity and the time at which it occurs, the rise time to maximum luminosity, and the decline rate of the luminosity in the tail of the curve. Such improved precision should prove very beneficial in calibrating the extragalactic distance scale. For the small sample that has been analyzed thus far, the average of the estimates

for the energy/nucleon in the Ni-deposition pulse is slightly greater than the binding energy of Ni--56 which indicates the fusion of 56 hydrogen nuclei into a Ni-56 nucleus.

Extra Presentation Information:

No extra presentation information has been added at this time.

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