Contribution ID: **13** Type: **not specified**

Ultra-stripped Type Ic supernovae from close binary evolution

Monday 24 March 2014 15:10 (20 minutes)

Recent discoveries of weak and fast optical transients raise the question of their origin. We investigate the minimum ejecta mass associated with core-collapse supernovae (SNe) of Type Ic. We show that mass transfer from a helium star to a compact companion can produce an ultra-stripped core which undergoes iron core collapse and leads to an extremely fast and faint SN Ic. In this Letter, a detailed example is presented in which the pre-SN stellar mass is barely above the Chandrasekhar limit, resulting in the ejection of only ˜0.05-0.20 M_sun of material and the formation of a low-mass neutron star. We compute synthetic light curves of this case and demonstrate that SN 2005ek could be explained by our model. We estimate that the fraction of such ultra-stripped to all SNe could be as high as 0.001-0.01. Finally, we argue that the second explosion in some double neutron star systems (for example, the double pulsar PSR J0737-3039B) was likely associated with an ultra-stripped SN Ic.

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Session Classification: Afternoon session - Parallel A