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Light curve of electron capture and Fe core collapse supernova: The diagnostic method of electron capture supernova

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Stars of 8-10 M⊙ are theoretically considered to become Super Asymptotic Giant Branch (SAGB), and explode as electron capture supernovae (ECSNe). However, there are no observation which is clearly identified as an ECSN. Although SN1054 (Crab Nebula) is considered to be an ECSN, we could hardly know its explosion as detail as modern observation. SN2018zd is a controversial object. Although it is recently proposed as an ECSN from its observational features (Hiramatsu et al. 2021), it is also proposed as an FeCCSN (Callis et al. 2021) at the same time. The reasons why we could hardly identify ECSN clearly are that observational characteristics of ECSNe comparing to Fe core collapse supernovae (FeCCSNe) of Red Super Giant (RSG) are not understood sufficiently, and the diagnostic method of ECSNe is not established yet. Although Kozyreva et al. (2021) shows that ECSN has blue plateau, they don't include circumstellar material (CSM) interaction. However, CSM interaction is quite important to understand the light curve because it might change the light curve significantly (Moriya et al. 2018), and SAGB is expected to experience large mass loss (Poelarends et al. 2008). Understanding the observational characteristics of ECSN including CSM interaction and observing it are highly demanded because it would be a clue to understand not only the stellar evolution of 8-10 M⊙ stars but also its nucleosynthesis, explosion mechanism, mass loss, and contribution to galactic chemical evolution.
We synthesized the multicolor light curves of ECSNe and low-mass FeCCSNe including CSM interaction not only based on the physically motivated properties (e.g. explosion energy estimated by first principles simulation) but also based on the wide range of parameters. The calculation is conducted using the multi-group radiation hydrodynamics code, STELLA (Blinnikov et al. 2000). The progenitor models of SAGB and RSG are obtained from Tominaga et al. (2013) and Sukhbold et al. (2016) respectively.
As a result, it is shown that ECSN has bluer plateau in multicolor light curve even if it has reasonably dense CSM although the bolometric light curve could be degenerate with FeCCSN for some parameter sets. The bluer color of ECSN is explained by tenuous and extended envelope structure of SAGB.
Using this characteristic, we propose a new diagnostic method of ECSN in which the transition time from plateau to tail phase (tPT) and the color index B-V at tPT/2 are used. Moreover, we applied the method to SN2018zd, which arises discussion whether it is an ECSN or an FeCCSN (Hiramatsu et al. 2021; Callis et al. 2021) and found that it is likely to be an ECSN.
In the talk, we will show the calculated light curves of ECSN and low-mass FeCCSN and discuss their characteristics. In addition, we will propose a new diagnostic method of ECSN. Also, we will mention our future work in which we will try to find an ECSN and reveal its nature.

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