Constraining massive star activities in the final years through properties of supernovae and their progenitors

R. Ouchi[1], K. Maeda[2]

[1,2]Department of Astrophysics, Kyoto University, Kyoto 606-8502, Japan

Recent observations of supernovae (SNe) just after the explosion suggest that a good fraction of SNe have the confined circumstellar material (CSM) in the vicinity, and the pre-SN enhanced mass loss may be a common property. The physical mechanism of this phenomenon is still unclarified, and the energy deposition into the envelope has been proposed as a possible cause of the confined CSM. In this work, we have calculated the response of the envelope to various types of sustained energy deposition starting from a few years before the core collapse. We have further investigated how the resulting progenitor structure would affect appearance of the ensuing supernova. While it has been suspected that a super-Eddington energy deposition may lead to a strong and/or eruptive mass loss to account for the confined CSM, we have found that a highly super-Eddington energy injection into the envelope changes the structure of the progenitor star substantially, and the properties of the resulting SNe become inconsistent with usual SNe. This argument constrains the energy budget involved in the possible stellar activity in the final years to be at most comparable or less than the Eddington luminosity. Such an energy generation however would not dynamically develop a strong wind in the time scale of a few years. We therefore propose that a secondary effect (e.g., pulsation or binary interaction) triggered by the moderate envelope inflation, which is caused by sub-Eddington energy injection, likely induces the mass loss.