Radio Transients Associated with Accretion-induced Collapse of White Dwarfs

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Accretion-induced collapse (AIC) is a theoretically predicted fate of white dwarfs (WDs). If a WD composed of oxygen, neon, and magnesium has a companion star which accretes matter onto the WD, the WD's mass can eventually become close to the Chandrasekhar mass limit. At this moment, the electron-capture reactions of magnesium can be triggered at the WD center and the WD collapses to be a neutron star (NS). (When a WD composed of carbon and oxygen becomes closer to the Chandrasekhar mass limit, the explosive burning of carbon leads to Type Ia supernovae). Merger of two WDs can also lead to the formation of a NS if a WD is left after the merger. For example, if a WD heavier than the Chandrasekhar mass limit that is composed of carbon and oxygen is formed after the merger and a carbon burning flame propagates from the surface to the center of the new massive WD, the WD is eventually composed of oxygen, neon, and magnesium. When the temperature becomes sufficiently low and the central density becomes high enough, the electron-capture reactions of magnesium can be triggered to transform the WD to a NS.

It is known that AIC ejects less than 0.1 $M_\odot$. However, little amount of radio active elements like ^{56}Ni are contained in the ejecta and AIC is considered not to be accompanied by a bright transient. However, the velocity of the ejecta from AIC is more than a few times faster than that in typical supernovae. The fast shock can accelerate electrons and the shock can be bright in radio thanks to the synchrotron emission from the accelerated electrons. In this study, radio light curves (LCs) of AIC that has fast shock waves are investigated.

Fig. 1 is an example of radio LCs obtained in this study [1]. The maximum peak luminosities in radio from SNe are about 10^{28} erg s^{-1} Hz^{-1}. Therefore, AIC can be as bright as or even brighter than SNe in radio wavelengths. AIC does not become bright in optical so transients very faint in optical but very bright in radio are promising candidates of AIC.

Because AIC is bright in radio, AIC can be discovered by performing transient surveys in radio. However, the expected event rate of AIC is small and a deep and wide radio transient survey is required to find it. We investigate expected numbers of AIC detections in the future planned radio transient surveys. As a result, we found that a planned transient survey with Square Kilometer Array can find a few AIC in a year. If we are able to perform a radio transient survey with a optical transient survey, we can efficiently discover radio-bright but optical-faint transients that are promising candidates of AIC.

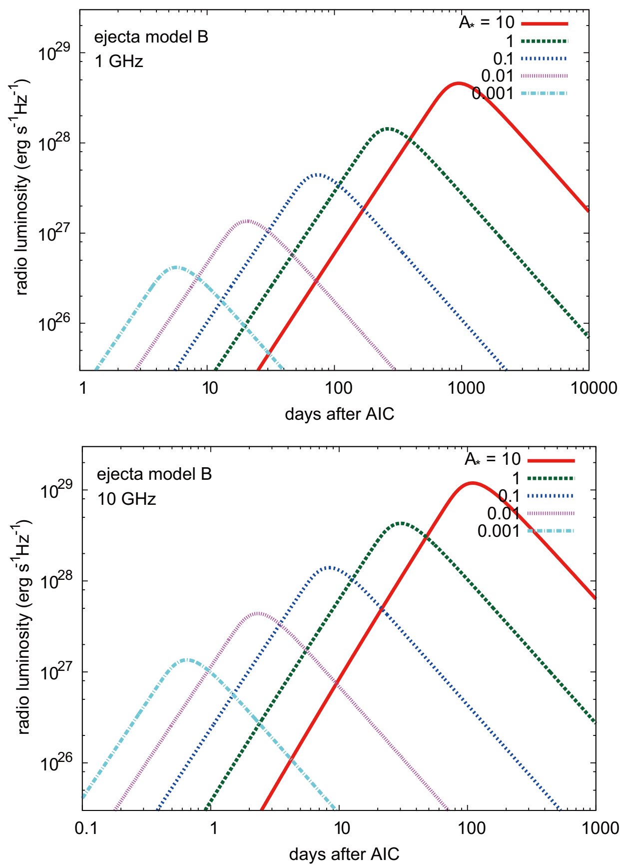

Figure 1: Examples of radio LCs of AIC at 1 and 10 GHz. $A_\star$=1 corresponds to AIC that explodes with in a circumstellar medium made by the mass-loss rate of 10^{-5} $M_\odot$ yr^{-1} and the wind velocity of 1000 km/s. $A_\star$ is proportional to the mass-loss rate and is inversely proportional to the wind velocity.

Reference

[1] Moriya, T. J.: 2016, *ApJL*, **830**, L38.