## The Beginning and Ends of Double White Dwarfs



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## High-Mass White Dwarfs in Gaia DR2: the Q Branch and Double-WD Mergers

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Recently, Gaia DR2 has revealed an enhancement of high-mass WDs on the H-R diagram, called the Q branch. The distribution of photometric ages and velocities of WDs around the branch suggest an extra cooling delay beyond current WD cooling models. To explore the properties of this delay, we statistically compare two age indicators – the dynamical age reflected by transverse velocity and the photometric ages calculated from WD cooling models – for more than one thousand high-mass WDs ( $1.08 - 1.23 \, M_{\odot}$ ). We show that, in addition to crystallization and merger delays, an extra 8-Gyr cooling delay is required on the Q branch, which affects only about 7 % of high-mass WDs.  $^{22}$ Ne settling in previously-metal-rich double-WD merger products may account for this extra delay. Independent of the explanation for the Q branch, we also show that  $20 \pm 6$  % of high-mass WDs originate from double-WD mergers, corresponding to a merger rate of  $(2.1 \pm 0.6) \times 10^{-14} \, M_{\odot}^{-1} \, yr^{-1}$  in our mass range. This is a direct observational constraint on the rate of double-WD mergers. In future, our method may be used to constrain the delay time distribution of double-WD mergers.

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