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White dwarf-neutron star binary progenitors for ultra-compact X-ray binaries

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White dwarf-neutron star binaries are among the main progenitors for ultra-compact X-ray binaries. They spiral in to contact by emitting gravitational waves and depending on the mass of the white dwarf turn into stably transferring ultra-compact X-ray binaries or produce supernova-like events following a tidal disruption of the white dwarf. Nearly all the stably transferring systems evolve through a phase during which mass transfer rates exceed the Eddington rate by orders of magnitude. The standard prescription for population synthesis codes assumes that during this phase all the excess material is lost from the system through a tightly collimated jet originating at the accretor. This is in contrast to observations of systems accreting at highly super-Eddington rates, such as SS 433, which are characterised by significant outflows from the accretion disc. To assess the role of such disc outflows, we perform hydrodynamic simulations of super-Eddington accretion in white dwarf-neutron star binaries. We measure the specific angular momentum lost through disc winds in our simulations and find that it is significantly larger than the angular momentum carried away through a jet. We use the measured angular momentum to construct a model of the long-term evolution of white dwarf-neutron star binaries and predict the outcomes of mass transfer. We find that more binaries result in unstable mass transfer than previously thought. In particular, all the binaries with CO white dwarfs and He white dwarfs more massive than about 0.2 solar masses, which were assumed to be stable, were found to be unstable. This result leads to a better agreement between the empirical inspiral rates of binary pulsars containing white dwarfs and empirical formation rates and compositions of ultra-compact X-ray binaries in the Galaxy.

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