Rotating progenitors of single and binary neutron stars and black holes

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We discuss the formation of dynamically unstable rotating stellar cores due to a merger process of two stellar cores in a common envelope. We applied population synthesis calculations to assess the expected fraction of such rapidly rotating stellar cores which may lead to fission and formation of a pair of proto-neutron stars. We have used the BSE (Binary Star Evolution) population synthesis code supplemented with a new treatment of stellar core rotation during the evolution via effective core-envelope coupling, characterized by the coupling time, τ_c. The validity of this approach is checked by direct MESA calculations of the evolution of a rotating 15 $M_\odot$ star. From comparison of the calculated spin distribution of young neutron stars with the observed one we infer the value $\tau_c \simeq 5 \times 10^5$ yr. We show that merging of stellar cores in common envelopes can lead to collapses with dynamically unstable proto-neutron stars, with their formation rate being $\sim 0.1 - 1$ per cent of the total core collapses, depending on the common envelope efficiency [1]. We also discuss low effective black hole spins inferred for LIGO GW150914 and LTV151012 events. Population synthesis calculations of the expected spin and chirp mass distributions of black holes from the standard field massive binary formation channel are presented for different metallicities (from zero-metal Population III stars up to solar metal abundance) [2].

References

[1] Postnov K. A., Kuranov A. G., Kolesnikov D. A., Popov S. B., Porayko N. K., 2016, MNRAS, 463, 1642

[2] Postnov K., Kuranov A., 2017, arXiv, arXiv:1702.08056

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