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Modelling Millisecond Pulsar Populations in Globular Clusters with NBODY6++GPU

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Millisecond pulsars (MSPs) are neutron stars with rotational periods as low as a few milliseconds. They are formed via angular momentum transfer from accreted materials from a companion star. In the high density environment of globular clusters (GCs), MSPs are likely to form through dynamically formed interacting binaries. In fact, over 300 MSPs are detected in GCs, more than half of the known MSP population. In this work, we attempt to model the MSP populations in intermediate mass clusters using the state-of-the-art N-body simulation code, NBODY6++GPU. We update NBODY6++GPU to include a pulsar spin-down mechanism due to magnetic braking and pulsar spin-up from accretion. These results are compared with observed MSP populations in GCs with similar masses. We then correlate the number of observable MSPs to physical conditions of GCs, and also attempt to predict merger events involving neutron stars in GCs. Since the gamma-ray emission from GCs originates from MSPs, we use the results to imply the observed gamma-ray emission. Different gamma-ray emission mechanisms within GCs are discussed, including the direct superposition of MSP gamma-rays, and the inverse Compton scattering of various photon fields, such as cosmic microwave background, intra-cluster star light and galactic star light by relativistic particles in pulsar winds. The differences of MSP populations in GCs and in the Galactic field are discussed, with the field population modelled by COMPAS, a rapid binary population synthesis code. MSPs ejected from the clusters through dynamical interaction contribute towards the GeV Excess at the Galactic Centre, and this effect is also discussed in this work.

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