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Simulations of binary neutron stars with reduced eccentricity[1]

WOLFGANG TICHY, Florida Atlantic University, NICLAS MOLDENHAUER, Theoretical Physics Institute, University of Jena, CHARALAMPOS MARKAKIS, Mathematical Sciences, University of Southampton, NATHAN JOHNSON-MCDANIEL, International Centre for Theoretical Sciences, Tata Institute of Fundamental Research, BERND BRÜGMANN, TIM DIETRICH, SEBASTIANO BERNUZZI, Theoretical Physics Institute, University of Jena — In order to construct initial data, binary neutron stars in quasi-circular orbits are usually modeled as helically symmetric, i.e., stationary in a rotating frame. This symmetry gives rise to a first integral of the Euler equation, often employed for constructing equilibrium solutions via iteration. We have extended this approach to the case of eccentric orbits by considering configurations at apoapsis that are instantaneously stationary in a rotating frame. We approximate the orbit of each star at apoapsis as an ellipse and use the ellipse's inscribed circle to construct a helical symmetry vector. In addition, we add a radial piece to the symmetry vector to model the inspiral. These modifications result in two freely specifiable parameters, an eccentricity parameter e and a radial velocity parameter v_r. If both are set to zero one recovers standard initial data. However, when such initial data are evolved one finds that the resulting orbits show a non-negligible eccentricity. We present an iterative method that allows us to adjust the parameters e and v_r in such a way that the orbits that result from evolution have reduced eccentricities.

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