General Relativity and Quantum Cosmology

Initial data for binary neutron stars with arbitrary spins

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In general neutron stars in binaries are spinning. Due to the existence of millisecond pulsars we know that these spins can be substantial. We argue that spins with periods on the order a few dozen milliseconds could influence the late inspiral and merger dynamics. Thus numerical simulations of the last few orbits and the merger should start from initial conditions that allow for arbitrary spins. We discuss quasi-equilibrium approximations one can make in the construction of binary neutron star initial data with spins. Using these approximations we are able to derive two new matter equations. As in the case of irrotational neutron star binaries one of these equations is algebraic and the other elliptic. If these new matter equations are solved together with the equations for the metric variables following the Wilson-Mathews or conformal thin sandwich approach one can construct neutron star initial data. The spin of each star is described by a rotational velocity that can be chosen freely so that one can create stars in arbitrary rotation states. Our new matter equations reduce to the well known limits of both corotating and irrotational neutron star binaries.

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