3D explosion dynamics of a critical-mass neutron star in a binary system

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In a compact double neutron star binary, a low-mass component undergoes an explosive destruction at the final evolutionary stage of the binary as a result of the collapse of the rotating iron core. We obtain a numerical solution for the three-dimensional dynamics of $0.1\,M_\odot$ iron ejecta with the energy release of 4.7 MeV per nucleon in the gravitational field of a high-mass neutron star. The numerical solution is obtained by the particle method, which is adequate for a collisionless description of the ejecta dynamics in the absence of the interstellar medium. As a test problem, the suggested model is compared with the well-known asymptotic solution (for vanishing m/M), which we also slightly improve and extend. We analyze in detail the separation of the ejecta into two categories of particles with hyperbolic and elliptical orbits. We obtain a number of results from the analytical solution, which allow us to estimate the kinetic energy of the ejecta as a function of the binary component mass ratio and the final pulsar velocity by applying momentum conservation law in the pulsar-ejecta system. Also, we carry out simulations with time-dependent energy release and a realistic profile of the ejecta velocity distribution. Further use of our calculations is promising to formulate the initial conditions for the three-dimensional hydrodynamic problem of the collision of ejecta with presupernova shells.