DYNAMICS OF NECK FORMATION IN HEAVY ION COLLISIONS[†]

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We suggest a dynamical model for the formation of the neck in a heavy ion collision. Neck formation is a new and unexplored phenomenon in physics and plays a crucial role in the time evolution of heavy ion reactions. Fusion excitation functions and properties of strongly damped collision are sensitive to the time evolution of the neck in the early stages of a heavy ion collision. For simplicity, to gain a qualitative understanding of neck formation we consider a symmetric case of two identical ions colliding head on (L = 0). To study the formation of a neck we choose a set of dynamical variables which describe various shapes of the reacting ions. We use three degrees of freedom a_o, β and s describing necking, stretching and the distance between the surfaces of the ions respectively. The time evolution of these coordinates is determined by solving the Euler Lagrange equations. The conservative force consists of the Coulomb force and the nuclear proximity and surface tension force. The inertias for the shape degrees of freedom are derived for an irrotational incompressible flow. Dissipative forces are calculated assuming one body dissipation, contribution from both wall and window friction are included. We start our calculation with two spheres at infinity. The proximity force favors a reduction of the radius of curvature of the surfaces of the ions which face each other. Therefore, as soon as the proximity force becomes appreciable the neck radius starts to grow. In addition, coupling between relative and collective velocities in the kinetic energy leads to an even faster growing of the neck. As the initial relative velocity increases, the neck radius decreases due to shorter interaction time. For heavier systems the Coulomb forces hindering neck formation become more substantial.

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