Friction in abrasion

A. Bacquias[1], V. Föhr[1], D. Henzlova[2], V. Henzl[2], A. Kelic[1], S. Lukic[1], M. V. Ricciardi[1], K.-H. Schmidt[1]

[1]GSI, Darmstadt, Germany; [2]MSU, East Lansing, Michigan, U.S.A

In very peripheral nucleus-nucleus collisions at energies well above the Fermi-energy regime friction phenomena set in. Friction appears as a consequence of interactions between the projectile and target matter in the overlapping region, and leads to a conversion of relative kinetic energy into excitation energy of projectile and target spectators. Due to this loss in kinetic energy, the velocity of spectator residues is slightly shifted towards the velocity of the reaction partner, i.e. projectile residues are slowed done. As for very peripheral collisions the interaction between the projectile and target matter in the overlapping region depends on in-medium nucleon-nucleon cross sections, the magnitude of the friction gives valuable information on the in-medium nucleon-nucleon cross section [1]: By comparing momentum distributions of spectator residues measured in high-resolution experiments with different theoretical predictions one can obtain the value of the in-medium nucleon-nucleon cross section needed to reproduce experimental data. However, this information was not readily accessible up to now. The reason is that in high-resolution experiments one obtains momenta of final fragments, i.e. after the evaporation of several particles, as a function of the mass or nuclear charge of the residue, while theoretical models describe only the first interaction stage of the collision, i.e. before the evaporation, and the momenta are given as a function of the impact parameter. As high-resolution experiments are not compatible with the full acceptance, until now there was no information on the impact parameter from such type of experiments, and, consequently, a direct comparison between the experiment and the theory was not possible. To overcome this limitation, we have introduced a method that can provide the momenta of the spectators as a function of impact parameter. Using this method we are able to directly compare high-resolution experimental data to the predictions of theoretical models, and thus get new insight into the friction.

In the present work, we profit from the experimental information on the cross sections and the velocity distributions of all nuclides obtained in an experiment at the fragment separator (FRS) of GSI in the reaction ^{136}Xe + Pb [2]. In addition, we exploit the correlation between the impact parameter and the mass of the heaviest residue in a reaction, which is well established for peripheral nuclear collisions [3]. A Glauber calculation [4] on the differential reaction cross section as a function of impact parameter is used to establish a correlation between the residue mass and the impact parameter and finally to find the desired correlation between the spectator velocity and the impact parameter. We apply this correlation down to mass *A*=40, as the nuclei with *A* < ~40 produced in the reaction ^{136}Xe+Pb can arise from processes where multifragmentation and emission of intermediate-mass fragments play important role. In these cases, more than one residue with comparable masses can be produced in one event, leading to the non-unique correlation between the residue mass and the impact parameter.

In figure 1 we present the average measured longitudinal velocity of the fragments in projectile frame as a function of impact parameter obtained using the above-mentioned procedure. For the present work, only data down to the impact parameter of ~11 fm are of interest; nevertheless, for the completeness, we show the whole set of data for which we have extracted the impact parameter. We have also made preliminary calculations with different theoretical models (QMD [5] and ISABEL [6]) or empirical parameterizations (Morrissey [7]). More detailed comparisons are under the way.

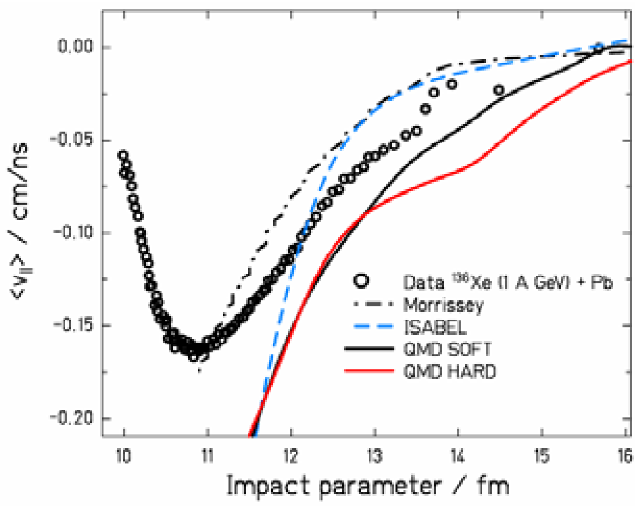

Figure 1: Average fragment velocities from Xe+Pb experiment in the Xe-beam frame (1000 *A* MeV) plotted against the impact parameter (dots). Full lines show the corresponding result from QMD calculation. Dashed line shows velocities according to ISABEL model. Morrissey systematic is shown with dash-dotted line.

References

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