PRE-EQUILIBRIUM ASPECTS OF HEAVY ION COLLISIONS†

S.I.A. Garpman*, S.K. Samaddar**, D. Sperber and M. Zielinska-Pfabe***
Department of Physics, Rensselaer Polytechnic Institute
Troy, NY 12181 USA

Nucleon spectra from the fragments in strongly damped collisions at lower energies suggest that the nucleons are emitted from a fully equilibrated system. On the other hand the energy spectra and nonisotropic angular distributions at higher energies suggest that no such equilibration occurs. In order to describe such a non-equilibration we assume the formation of a hot compressed localized zone, in the early stages of the reaction. This zone is the source of the fast forward peaked nucleons. The high energy component in the spectrum is due to the high temperature of the zone. The forward peaking is attributed to the refraction of the nucleons at the surface of the amalgamated system. We show that for energies below 20 MeV/AMU nuclear matter can still be considered as incompressible. At present it is not clear at what energies compressibility should be considered significant. Due to the long mean free path in cold nuclear matter, we assume that the hot zone is formed in the interface of the colliding ions. The energy and angular distributions of nucleons were calculated for several reactions and in each case contributions from all partial waves were added. The hot zone is allowed to cool off by exchange of particles with the surrounding cold nuclear matter. This allows the determination of the relaxation time for the decay of the zone. In addition contributions due to even earlier stages of the reaction as manifested by promptly emitted particles were incorporated into our calculation. These latter particles are due to coupling of the relative velocity to the Fermi velocity. We have noticed that for energies of only a few MeV/AMU above the Coulomb barrier these promptly emitted particles dominate the pre-equilibrium emission while at higher energies the decay of the hot zone is more important. We also showed, using mean field theory that at energies above 50 MeV/AMU the hot zone becomes unstable leading to a considerable increase in nucleon multiplicity.

References

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*Department of Physics, Lund University, Lund, Sweden
**Present address: Darjeeling Government College, Darjeeling, W. Bengal, India.
***On leave from Institute for Nuclear Research, Warsaw, Poland.