

DISSIPATIVE PHENOMENA IN NUCLEAR COLLISIONS USING ^{12}C
IN THE ENERGY RANGE 30 - 86 MeV/u

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In heavy ion induced collisions dissipative phenomena have been largely studied at low energy (< 10 MeV/u). With the construction of intermediate energy accelerators it becomes clear that the intervening decade will be more focused on the energy range 10 - 100 MeV/u. It is in this transitional energy region that the collision speed surpasses both the sound velocity and the intrinsic Fermi velocity. It is generally thought that the energy damping proceeds essentially through one body collisions at low energy and that when increasing the bombarding energy, nucleon-nucleon collisions will compete more and more and become the dominant source of energy dissipation for relative velocities above the Fermi velocity.

Using the carbon beam at the S.C. at CERN (86 MeV/u), we have recently undertaken an experimental programme in order to investigate these questions. The accelerated carbon beam was also slowed down at 60 and 30 MeV/u to make studies over a large energy range. Two types of events were observed : first, the fission fragments from interactions between ^{12}C and heavy targets (^{238}U , ^{232}Th , ^{197}Au) and secondly heavy fragments or fusion residues from collisions between ^{12}C beam and a Ni target. Light charged particles emitted in coincidences with fission or heavy fragments were also detected.

With heavy targets the transferred momentum can be easily deduced from the angular correlation between the two fission fragments ; this is a trivial kinematical effect : the more recoil is given to the target-like nucleus, the smaller is the relative angle between the two fission fragments. If for very small momentum transfers the fragments are emitted 180° apart in the lab system, the relative angle is minimum for full projectile momentum transfer. On U and Th targets, only a few MeV are needed to overcome the fission barrier and consequently all the reaction channels end up by fission. Therefore, we observe a very broad angular correlation extending from zero

to the maximum possible momentum transfer. An evolution is registered with bombarding energy : if at 30 MeV/u the most probable momentum transfer corresponds roughly to 8/10 of the maximum allowed transfer, at 60 MeV/u the peak is shifted down to approximately 2/10 of the maximum. Nevertheless, it is shown that still a few percents of the total cross section imply full momentum transfer. This gives a unique opportunity for studying the deexcitation of heavy systems heated by more than 600 MeV excitation energy.

With Ni target the deexcitation is done mostly by particle emission leading to a bunch of residual nuclei. The latter could be easily isolated from particles of low mass (below the projectile mass) by using very thin solid state Si detectors mounted in telescopes. Their angular distribution is forward peaked but gently decreasing as expected for a nucleus after evaporation of numerous particles. In coincidence events with light particles the time-of-flight difference was measured and the mass of the fragment could be deduced. From a very preliminary analysis it seems that the most probable masses are very similar at 86, 60 and 30 MeV/u. This is consistent with the data observed on heavy targets : the higher the bombarding energy, the lower the fraction of transferred momentum. If we assume this effect to be due to a reduction of the number of transferred nucleus from the projectile to the target (but a full velocity), then the energy deposit would be very similar at high and low energy and consequently the residual masses close to each other. We can also indicate that for a given bombarding energy the most probable mass decreases when the angle of detection increases as expected for an evaporation residue. Finally a very preliminary analysis of light particles emitted in coincidences with heavy fragments shows that a large part of particles emitted close to the direction of the beam have roughly its velocity.