CORRELATIONS BETWEEN PROJECTILE AND TARGET BREAKUP: A COMPARATIVE STUDY OF NUCLEUS-NUCLEUS COLLISIONS AT 75, 175 AND 2000A MeV.

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Nucleus-nucleus collision in three different energy intervals: 50-100, 150-200 and 1900-2100A MeV have been studied in nuclear emulsion.[1,2] The reactions were ^{16}O + average emulsion target (H,C,N,O,Ag,Br). In each event, all emitted charged particles were recorded, projectile fragments with $Z \geq 2$ identified and the number of charged particles from the **target** nucleus was determined. The results are discussed in terms of the geometrical aspects of Heavy Ion collisions and direct comparisons are made with the Goldhaber fragmentation model[3].

Frequently, the ^{16}O projectile breaks up into one or more He nuclei. Fig. 1 shows the average target particle multiplicity, <NT>, in events with different number of He particles (N) from the projectile. Only events where He is the largest remnant of the projectile are included. The similarity of <NT> over the wide energy interval, implies that 3 and 4* He events are the most peripheral. We observe, when looking at angular distributions of He, that when emitted in 1*He events, they give a broad, flat distribution. However, in 4*He events, He is emitted at very small angles. When added up with 2 and 3*He events, they form an inclusive spectrum, quite in agreement with the simple fragmentation, although there are contributions both from gentle and more violent collisions, which lead to a severe destruction of the target nucleus.

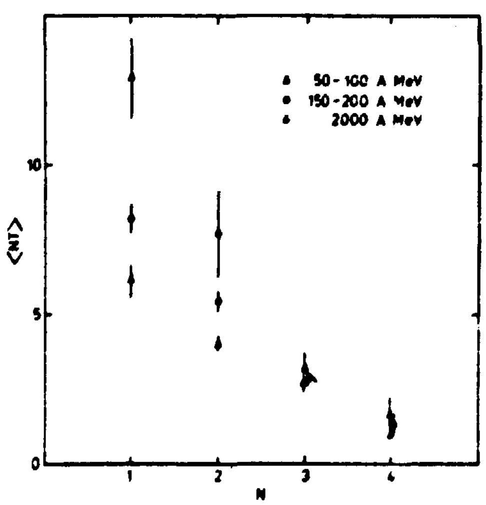

Fig. 1.

It turns out that the sum of the charges, tied up in multiply charged projectile fragments, ΣZ_{Fr}, is a good measure of the excitation of the spectator pieces. An example: Events with 3*He + two Z=1 particles left of the projectile have the same NT distribution as

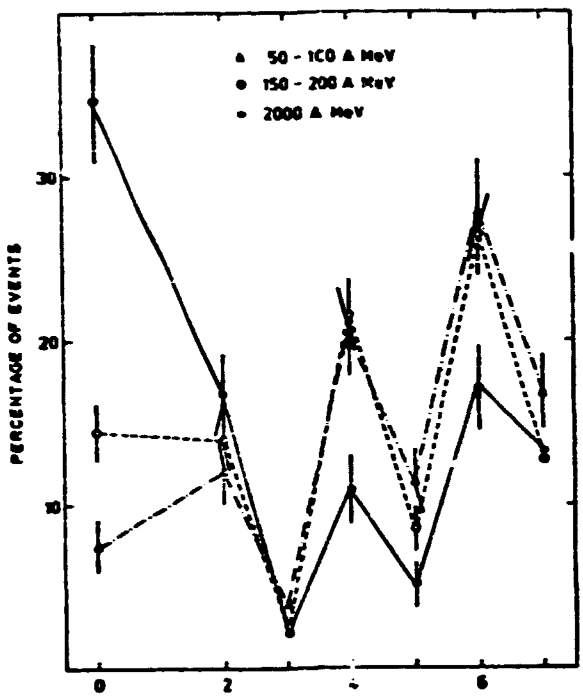

Fig. 2.

events with one C fragment + + two Z=1 particles. They are thus grouped together, with the notation $\Sigma Z_{Fr}=6$. Fig. 2 shows the relative abundancies of each ΣZ_{Fr} group at the three energies. First there is an apparent odd-even behaviour, probably reflecting the ^{16}O alpha particle substructure. The probability that the projectile is completely destroyed is greater at 2000A MeV. Since the geometry is the same at the three energies, the result shows that the spectator break-up is not only ruled by the geometry in the collision.

A calculation of the geometrical overlap between the nuclei, shows that only in 18% of the events, the projectile is completely covered by the target nucleus. Thus at 2000A MeV also collisions with non-overlapping pieces of the projectile can lead to a complete destruction of the projectile. On the other hand, at 50-100A MeV the projectile might survive in larger pieces also when the nuclei are fully overlapping.

In Fig. 3 we examine the deviations $-\langle \Delta y \rangle$, from the projectile rapidity and the average transverse momenta, $\langle P_\perp \rangle$, of projectile fragments and their correlation to the target multiplicity $\langle NT \rangle$. At 150-200A MeV the rapidity shift is consistent with the fragmentation model (dotted line). Decreasing the beam energy the projectile gets more damped in the collision, resulting in larger shifts. Transverse momenta at 50-100A MeV are significantly greater than at 150-200A MeV. At the lowest energy Coulomb repulsion have been proved to be of importance[4], leading to an orbital deflection of the projectile, prior to breakup.

Both the rapidity and $\langle P_\perp \rangle$ are, at least at 50-100A MeV, correlated to the

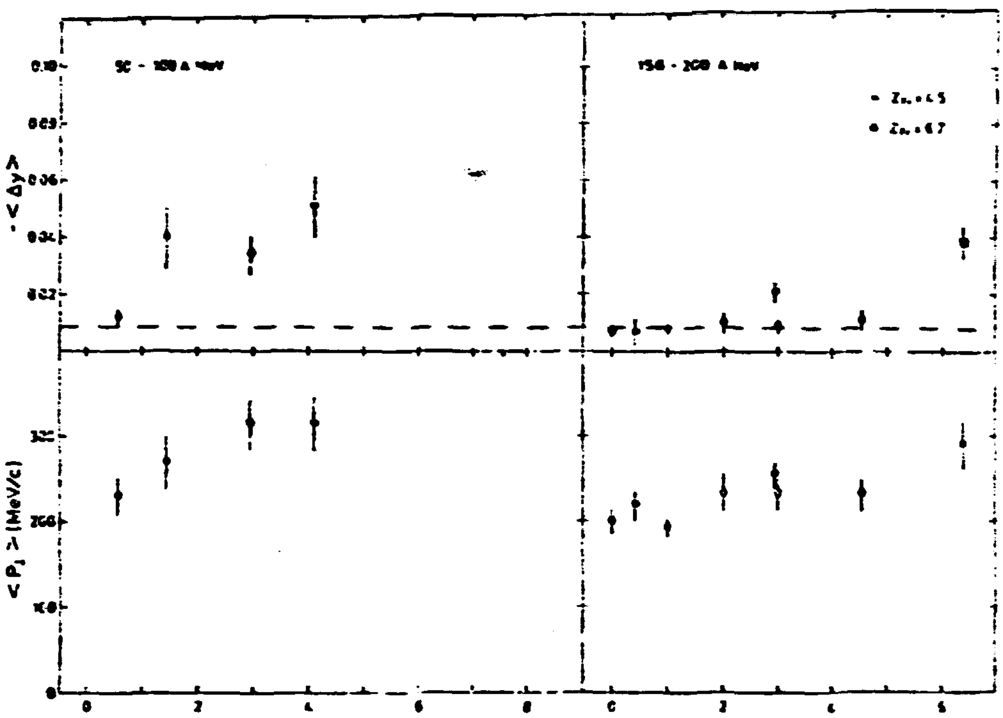

Fig. 3. <NT>

degree of breakup of the target. Similar observations could be done also for He nuclei from the projectile. This contradicts the idea of factorization in peripheral nucleus-nucleus collisions. The breakup properties of the projectile could not be regarded as independent of what happens in the target, a basic ingredient in many descriptions of the reaction mechanism in peripheral collisions.

References:

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