Multifragmentation of Gold Projectiles Interacting with Light Targets

W .D. Kunze for the ALADIN-Collaboration

The first experiment of the ALADIN collaboration indicated a target independence of the fragmentation pattern in gold induced reactions at 600 AMeV [1]. In a subsequent experiment a large variety of projectile/target combinations was investigated at beam energies between 400 and 1000 AMeV. In the lower part of Fig.1 the mean number $\langle M_{imf} \rangle$ and the mean scaled number $\langle M_{imf}/Z_{bound} \rangle$ of intermediate mass fragments (IMF, $3 \leq Z \leq 30$) are shown as a function of the charge sum Z_{bound} ($Z_{bound} = \Sigma Z,\ Z \geq 2$) for Au + Be, C, Al collisions at 400, 600 and 1000 AMeV. For orientation, the dashed lines in Fig.1 mark the mean IMF multiplicity and $\langle M_{imf}/Z_{bound} \rangle$ observed in Au + Au collisions. For this heavy system no energy dependence between 400 and 1000 AMeV is found, i.e already at 400 AMeV the maximum IMF production (at $Z_{bound} \approx 40$) is reached [3]. For lighter targets, however, the maximum IMF production requires beam energies beyond 400 AMeV. SMM

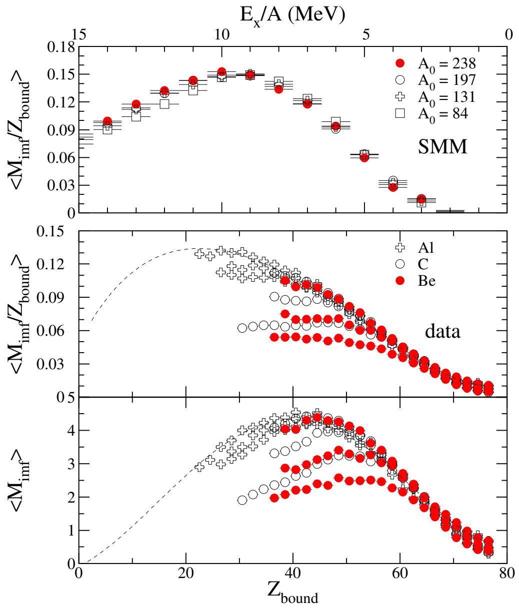

Figure 1: Mean scaled multiplicity $\langle M_{imf}/Z_{bound} \rangle$ (center panel) and mean multiplicity $\langle M_{imf} \rangle$ (lower panel) of intermediate mass fragments as a function of Z_{bound} for Au + Be, C, Al collisions at 400, 600 and 1000 AMeV. The upper panel shows the mean scaled multiplicities $\langle M_{imf}/Z_{bound} \rangle$ of IMFs as a function of the prefragment excitation energy E_x/A predicted by SMM calculations.

calculations [4] predict for excitation energies below $\approx$ 9 MeV a monotonously increasing relation between $\langle M_{imf}/Z_{bound} \rangle$ and the prefragment excitation energy E_x/A. Since this relation is independent of the prefragment size A_0 (upper part of Fig.1) $\langle M_{imf}/Z_{bound} \rangle$ may serve as a measure of the excitation energy. In order to relate this excitation energy to the collision geometry an impact parameter scale was derived from Z_{bound} [2] (the smallest Z_{bound} value shown in Fig.1 corresponds to 1.5 % of the total integrated yield, i.e to 12 % of the reduced impact parameter $\hat{b} = b/b_{max}$). The upper part of Fig.2 shows the mean scaled IMF multiplicity $\langle M_{imf}/Z_{bound} \rangle$ as a function of b. Using the $\langle M_{imf}/Z_{bound} \rangle$ vs. E_x/A relation predicted by SMM

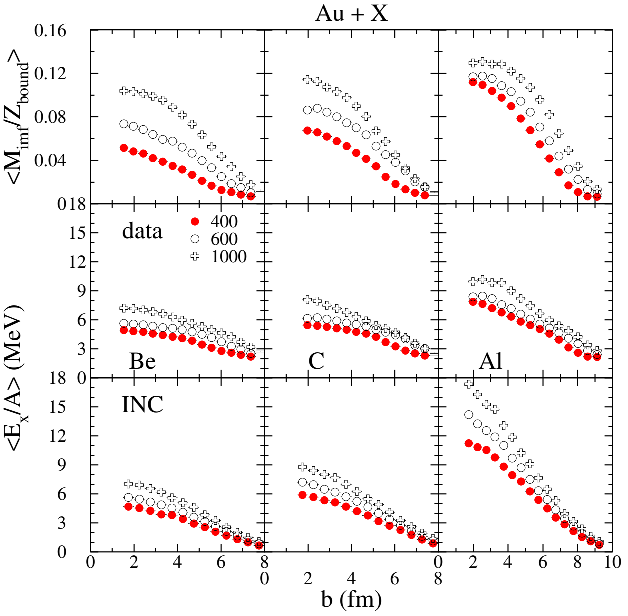

Figure 2: Mean normalized multiplicity $\langle M_{imf}/Z_{bound} \rangle$ (top panel) and mean prefragment excitation energy per nucleon as a function of the reconstructed impact parameter. The lower panel shows the impact parameter dependence of $\langle E_x/A \rangle$ predicted by INC calculations.

calculations (top part Fig.1) the observed $\langle M_{imf}/Z_{bound} \rangle$ values can be translated into an excitation energy per nucleon (center panel). In particular for more central reactions on the Al target, these excitation energies are significantly higher than $\langle E_x/A \rangle$ values provided by previous analyses based on statistical multifragmentation calculations [4],[7],[8]. This dicrepancy is even more significant for Au + Au collisions (not shown) for which the present method results in excitation energies close to the values obtained from an experimental energy balance [5].

For comparison, mean prefragment excitation energies predicted by INC - simulations [6] are shown in the lower part of Fig.2. For the Be and C targets the impact parameter as well as the beam energy dependence of $\langle E_x/A \rangle$ is in good agreement with the excitation energies extracted from the experimental data on the basis of the SMM calculations. For the more central Au+Al interactions, however, the INC simulations predict significantly higher excitation energies.

References

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