Electromagnetic Fission of Uranium at 600 and 1000 AMeV ^{G}

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In an experiment with the ALADIN spectrometer electromagnetic fission of uranium projectiles at 600 and 1000 AMeV was investigated. Seven different targets made of beryllium, carbon, aluminium, copper, indium, gold and uranium were used. Individual charges of the fission fragments were resolved using the TP - MUSIC detector. The multiplicity of light charged particles emitted from the interaction zone was determined with a Si-CsI hodoscope.

Since the excitation energies for electromagnetic fission are dominated by the excitation of the giant dipole resonance (∼13 MeV), the probability for the emission of light charged particles is negligible [1]. The contribution of electromagnetic fission events to the total fission cross section can therefore be enhanced by a cut on the sum of the fission fragment charges of Z_{sum} = 92. An additional condition is that no charged particle was detected in the hodoscope. The increase of the electromagnetic contribution with the charge of the target nucleus was shown elsewhere [2].

The total cross section determined under these conditions still contains both the cross sections for electromagnetic fission and peripheral nuclear processes. To disentangle the electromagnetic from the nuclear contribution the concept of factorization was applied [3]. Under the assumption that the total cross section measured for the Be - target is almost entirely due to nuclear processes the nuclear contribution for the heavier targets can be determined.

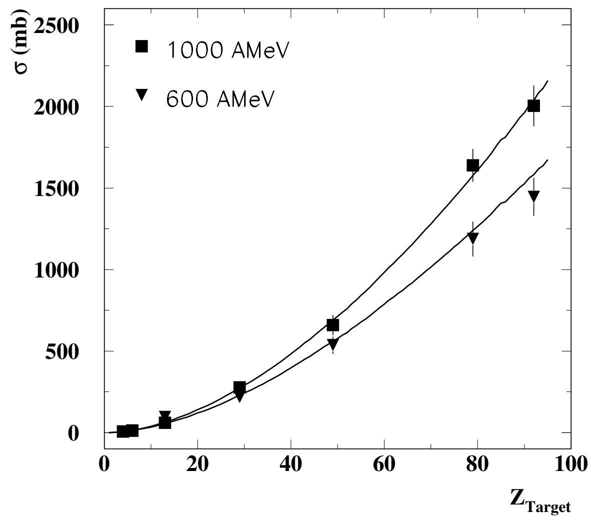

Figure 1: Cross sections for electromagnetic fission of ^{238}U projectiles at E/A = 600 and 1000 MeV beam energy as a function of the atomic number Z of the target. The lines show the predictions of calculations based on the extended Weizsäcker – Williams theory.

The factorization ansatz assumes that nuclear fragmentation cross sections can be approximated by $\sigma^F_{PT} \approx \gamma^F_P \gamma^P_T$ where P,T and F indicate the dependence on the projectile, target and the fragmentation channel respectively. The cross section ratios

$$R^F(T) = \frac{\sigma^F_{U,T}}{\sigma^F_{U,Be}} \approx \frac{\gamma^U_T}{\gamma^U_{Be}} \tag{1}$$

should therefore be independent of the fragmentation channel F. To test the validity of the concept of factorization we investigated those events with Z_{sum} in the range between 86 and 91. The dependence of the ratio on Z_{sum} is found to be small and the assumption of factorization is therefore justified. The nuclear contribution for all the heavier targets can be determined by multiplication of the total cross section for the Be - target with the ratio $R(T)$, $\sigma_{nucl}(T) = \sigma(Be)R(T)$. Small systematical uncertainties are achieved due to the selectivity of our initial cuts which reduce the nuclear background to less than 20% of the total cross section.

The cross sections for electromagnetic fission of uranium determined by subtraction of the nuclear background from the total cross section are shown in Fig.1. Furthermore we show the energy dependence of the cross sections for the reaction ^{238}U + ^{208}Pb including results from other experiments. Polikanov et al. determined the cross sections at 100, 500 and 1000 AMeV [4]. Our results and the data of Justice et al. [5] at 120 AMeV were scaled to the Pb target.

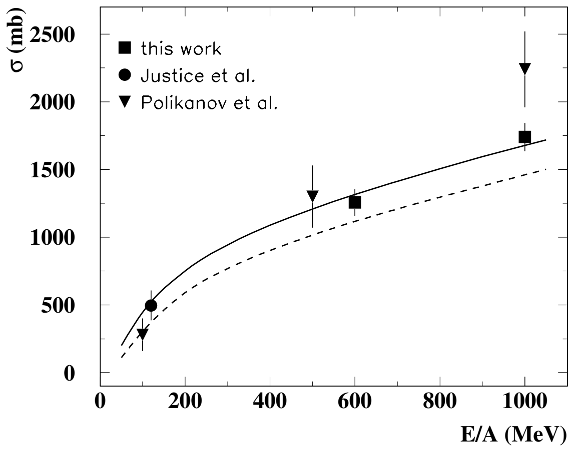

Figure 2: The cross section for electromagnetic fission as a function of the beam energy for the system ^{238}U + ^{208}Pb in comparison to the prediction of the WW calculations.

Extended Weizsäcker - Williams calculations using the BCV parametrization for the interaction radius, experimental photonuclear cross sections and E1/E2 - excitations of the giant resonances were done [6]. The theoretical calculations can well reproduce the experimental cross sections.

References

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