Charge-pickup reactions induced by interactions of 1 *A* GeV ^{208}Pb with different targets

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The systematic measurement of residual nuclide cross sections from the interaction of relativistic 1 *A* GeV ^{208}Pb projectiles with different targets forms part of a comprehensive study of fragment formation in a neutron-generating target for accelerator-driven systems (ADS) [1]. The data published so far [2],[3] do not include charge-pickup reactions, which are of specific importance for estimating the production of polonium isotopes in a lead-bismuth ADS target. From the basic understanding of charge-exchange reactions, data on charge-pickup reactions, being sensitive to the nucleonic aspects of relativistic heavy-ion collisions[4], are also an important test for any microscopic model on nucleon-nucleon interactions. However, these studies were limited by lack of experimental data especially those with full isotopic resolution.

The measurements with a 1 *A* GeV ^{208}Pb beam were performed at GSI-Darmstadt using the full advantage of relativistic collisions in inverse kinematics. The experimental method and data-analysis procedure have been described in detail in ref. [2], and here only a short overview will be given. The primary beam of ^{208}Pb impinged on a 87 mg/cm^2 thick liquid-hydrogen, 206 mg/cm^2 liquid-deuteron target, and on the empty target container corresponding to 36 mg/cm^2 titanium target. The fragment separator FRS [5] and the associated detector equipment were used in order to separate and to identify the reaction products. The production cross section of each isotope was determined from the measured velocity distributions.

To compare our data with calculations, we used two different intra-nuclear cascade models: ISABEL [6] and INCL4[7], both coupled to the same evaporation-fission model ABLA [8]. In the case of the ^{208}Pb + Ti reaction, calculations were performed only with ISABEL, because in the present version of INCL4 the heaviest target that can be used in calculations is ^{4}He. The results of these comparisons are shown in figure 1. While ISABEL is reproducing quite satisfactory the measured bismuth isotopic distribution for the ^{208}Pb + Ti reaction, discrepancies between model calculations and experiment are apparent for proton and deuteron targets. INCL4 is over-predicting the neutron-rich side, especially for the proton-induced reaction. On the other hand, ISABEL is giving better agreement with this part of the distribution, but in the same time over-predicting the neutron-deficient side. It is difficult to judge which model is more suitable for application. The basic physics contained in both models is the same, and the different predictions are the results of different implementations inside INCL4 and ISABEL.

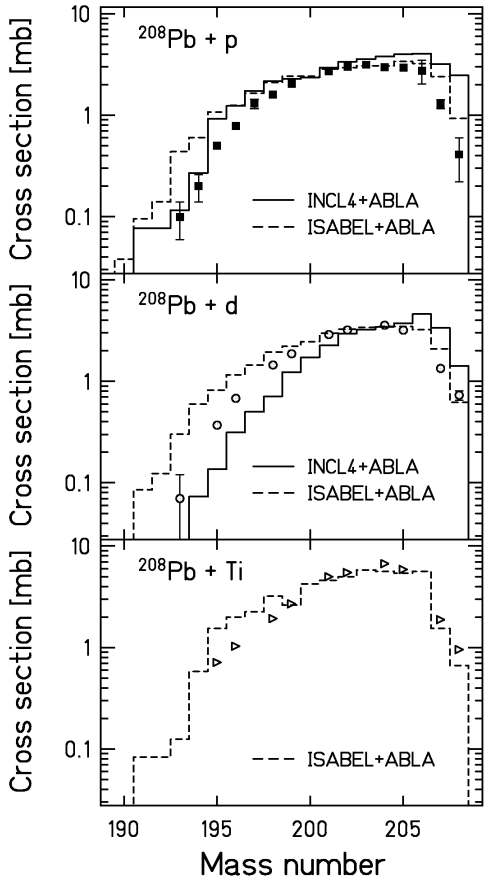

Figure 1. Experimental (full squares, open dots, and open triangles) and calculated (ISABEL + ABLA and INCL4 + ABLA) isotopic distributions of charge-pickup products in the interactions of 1 *A* GeV ^{208}Pb projectiles with hydrogen, deuteron and titanium.

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