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Multinucleon transfer processes in the ^{197}Au+^{130}Te system studied with a high-resolution kinematic coincidence

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The production of neutron-rich nuclei in the mass region A ~ 200, in particular along the neutron closed shell N = 126, has recently received strong attention since these nuclei are fundamental to understand different physical aspects, from the shell evolution far from stability to the investigation of the path chosen by the r-process to synthesize the heavy elements. The difficulties in accessing this region with reactions between stable beams and in identifying such heavy nuclei in A and Z with the present techniques are the main reasons why few experimental data exist so far. Moreover secondary processes, like particle evaporation and transfer-induced fission, may play a non-negligible role when heavy nuclei are involved and may significantly shift the final yield distributions to lower masses.

Multinucleon (MNT) transfer reactions at energies close to the Coulomb barrier have been indicated as a promising mechanism to produce neutron-rich nuclei around the N = 126 region of the nuclide chart. In some recent experiments the study of the mechanism and the probability for the production of neutron-rich heavy nuclei with MNT reactions was attempted by employing either γ-particle coincidences, high-efficiency but low-resolution particle-particle coincidences or radiochemical methods.

In this context we performed an experiment to study multinucleon transfer reactions at near-barrier energies in the ^{197}Au+^{130}Te system employing a novel method which consists in the simultaneous detection of light and heavy transfer products where one of the reaction partners (the light one) is identified with high resolution. We exploited the performance of the PRISMA spectrometer to identify isotopes in the tellurium region, while the coincident Au-like partners were detected with a dedicated set-up, the NOSE, specifically built and coupled to PRISMA. We chose the neutron-rich ^{130}Te to populate neutron transfer channels leading primarily to neutron-rich Au isotopes. The use of inverse kinematics allowed to achieve high efficiency and resolutions for both partners in spite of the low bombarding energy.

The A, Z and Q value distributions of the light partner of the reaction were determined through an event-by-event trajectory reconstruction in PRISMA. The cross sections for neutron transfer channels were extracted and compared with the ones calculated with the GRAZING code. The mass of the coincident heavy partner was determined from the correlated scattering angle and Time-of-Flight in NOSE, by assuming the reaction binary in character. This allowed, via a high resolution mass-mass correlation and the comparison with Monte Carlo simulations, to study the final mass distribution of the heavy partner and the effect of secondary processes. This also allowed to extract the requirements that are needed in order to have a clear identification in mass A and charge Z of the heavy reaction products.

The experimental method and results and the comparison with theoretical calculations will be presented.

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