Production of neutron-rich nuclides in peripheral collisions of ^{86}Kr (15 MeV/nucleon) projectiles with ^{64}Ni,^{58}Ni and ^{124}Sn, ^{112}Sn targets

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A large part of our recent efforts has been directed to the production and separation of RIBs in peripheral collisions below the Fermi energy. High intensity beams at this energy range are expected from the refurbished K150 cyclotron and can be exploited for the production of RIBs with the aid of a large-bore superconducting solenoid as a preseparator before a heavy-ion gas stopper [1]. Our recent measurements and simulations indicate that the application of the deep-inelastic transfer mechanism [2,3,4] appears to be a very effective way to obtain neutron-rich rare isotopes at the K150 energies.

Aiming at obtaining systematics on production rates, we performed a series of measurements with a 15 MeV/nucleon ^{86}Kr beam striking targets of ^{64}Ni,^{58}Ni and ^{124}Sn, ^{112}Sn. The projectile fragments were collected and identified using the MARS recoil separator applying the techniques developed and documented in [2,3]. The Kr beam was sent on the primary target location of MARS with an inclination of 4^o. After interaction with the target, the fragments traversed a PPAC at the intermediate image location (for position/Bρ measurement and START time information) and then they were focused at the end of the device passing through a second PPAC (for image size monitoring and STOP time information). Finally the fragments were collected in a 5x5 cm^2 ΔE-E Si detector telescope (60 and 1000 μm thickness). Following standard techniques of Bρ-ΔE-E-TOF (magnetic rigidity, energy-loss, residual energy and time-of-flight, respectively), the atomic number Z, the mass number A, the velocity and the ionic charge of the fragments were obtained on an event-by-event basis (see, e.g., [3]). Data were obtained in a series of magnetic rigidity settings of the spectrometer to cover the energy and charge state distributions of the fragments. In order to obtain total cross sections from the measured yields at 4^o, we used a model approach as described in our previous works [2,3,4]. First we performed calculations of the yields with the codes DIT [5] for the primary interaction stage and GEMINI [6] for the deexcitation stage of the reaction. We then performed filtering of the DIT/GEMINI results for the limited angular acceptance of the spectrometer and the Bρ range covered in the measurements. We used the ratio of the filtered to unfiltered simulations to correct the measured data (obtained in the limited angular acceptance of the spectrometer) and extract total production cross sections for each projectile-like fragment.

Figure 1 shows the cross sections of projectile-like fragments of elements Z=35-30 from the reactions ^{86}Kr (15 MeV/nucleon) + ^{64}Ni, ^{58}Ni (black and red points, respectively). Similarly, figure 2 shows the cross sections of projectile-like fragments of elements Z=35-30 from the reactions ^{86}Kr (15 MeV/nucleon) + ^{124}Sn, ^{112}Sn (black and red points, respectively). The results indicate that along with proton-removal products, neutron-pickup products are produced in substantial yields, as expected from a deep-inelastic transfer mechanism at these energies [2,3,4]. Especially for the present 15 MeV/nucleon data, we observe enhanced cross sections of neutron pick-up products near the projectile. We are currently working on detailed simulations of the cross sections using an improved version of the DIT model approach [4], as well as, the CoMD code [8].

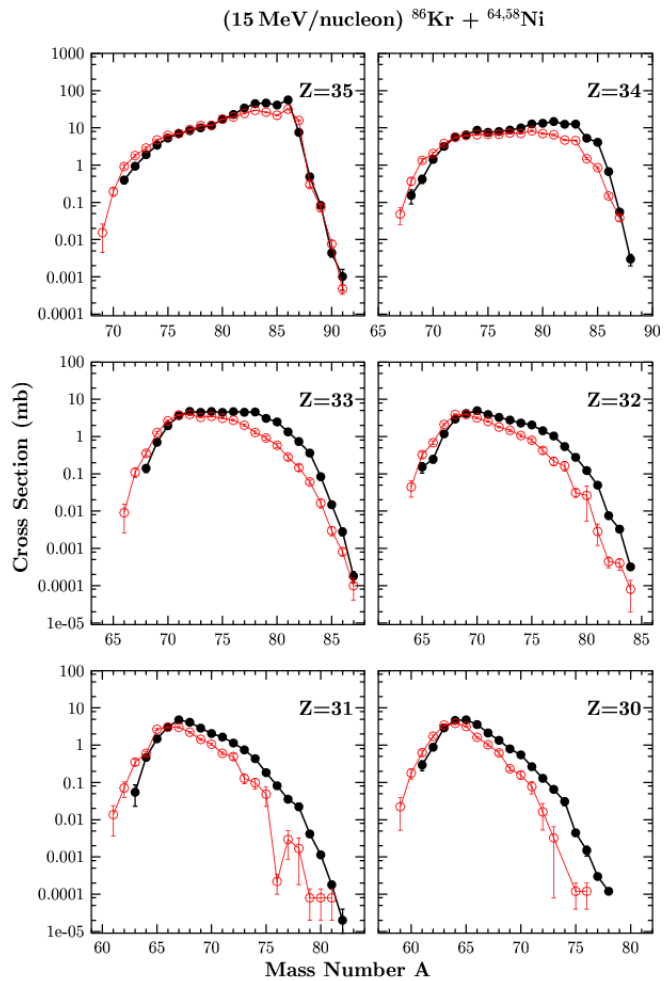

FIG. 1. Cross sections of projectile-like fragments of elements Z=35-30 from the reactions ^{86}Kr (15 MeV/nucleon) + ^{64}Ni (black points) and ^{86}Kr (15 MeV/nucleon) + ^{58}Ni (red points).

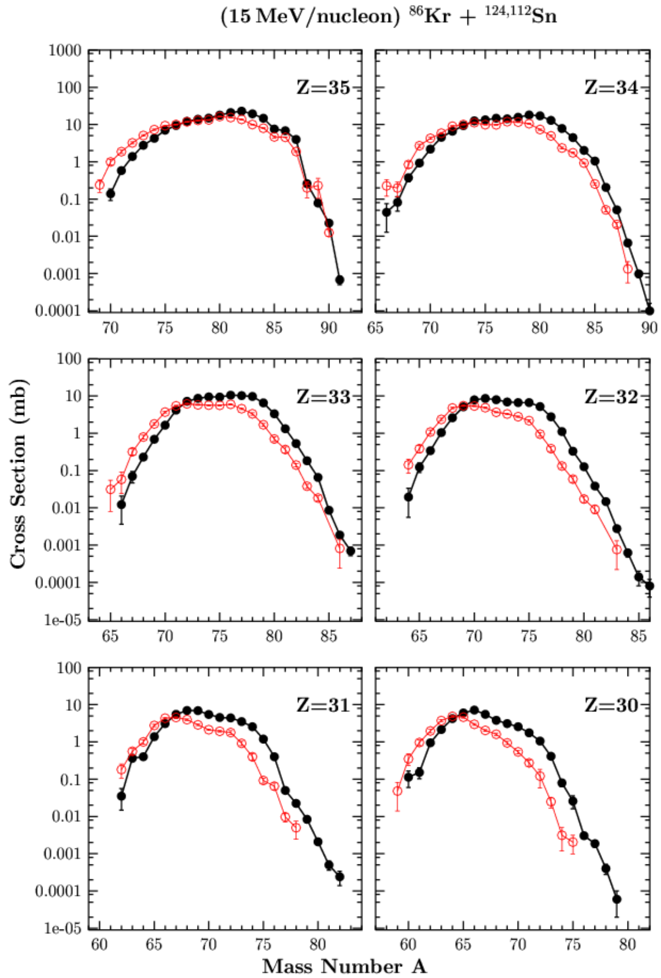

FIG. 2. Cross sections of projectile-like fragments of elements Z=35-30 from the reactions ^{86}Kr (15 MeV/nucleon) + ^{124}Sn (black points) and ^{86}Kr (15 MeV/nucleon) + ^{112}Sn (red points).

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