$^{48}Ca + ^{48}Ca$ Euroball Experiment

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We have performed a three day measurement of the $^{48}Ca + ^{48}Ca$ reaction at the european large gamma array EUROBALL. The beam of 140 MeV ^{48}Ca ions was delivered by the XTU Tandem at Legnaro National Laboratories. The ion source was running for three days using a 17 mg calcium hydrate CaH_2 pill enriched to about 70% ^{48}Ca content. The material was prepared at Köln University in a procedure designed for optimizing the ion source output. The 0.74 mg/cm^2 ^{48}Ca target was made of 92.9% enriched material evaporated on 40 mg/cm^2 ^{208}Pb backing. The front side of the target was covered by a 0.06 mg/cm2 layer of evaporated ^{208}Pb to protect the Ca surface from oxidation. The bombarding beam ions of ^{48}Ca at 140 MeV were slowed down in the thin Pb layer by less than 0.5 MeV and in the Ca target material by 11 MeV. The incident energy of 140 MeV and 129 MeV at both ends of the Ca target corresponds to collision energy 24% and 14% above the Coulomb barrier respectively. The beam particles and all reaction products were stopped in the thick backing.

The EUROBALL multidetector array operated in Legnaro in a complex setup made up of three groups of detectors. At the time of the experiment it consisted of 14 cluster detectors (7 germanium segments each) at backward angles, 26 clovers (4 segments each) at 90° and 29 single crystal tapered detectors that covered the forward angles. An absolute efficieny of about 7% was measured for the whole instrument. The data acquisition system was set to record all 3-fold and higher fold events. Altogether $5*10^9$ events were stored on tape. The sorting and preliminary analysis of the data was conducted at Padova University using the GSORT-TRACKN programs. Gamma spectra in the range of 4 and 20 MeV were calibrated and aligned from source measurements. The final energy resolution of 2.7 and 5 keV was achieved for lines of 1099 and 3833 keV, respectively. A dedicated addback procedure was applied for the sorting of composite detectors data. By summing up the energies recorded in two neighboring segments instead of treating both of them as separate hits we enhanced the peak-to-total ratio and the efficiency of detection especially for high energy gammas.

First results of the experiment were some spectroscopic findings in nuclei close to ^{48}Ca beam and target nucleus. The deep-inelastic processes and few nucleon transfer from and to ^{48}Ca populate a number of exotic neutron rich nuclei. The structure of most of them is poorly known as they are unaccessible by standard gamma spectroscopy techniques. In another contribution to this report we describe new results obtained for ^{44}Ar and ^{46}Ar isotopes [1].

The reaction cross section is dominated by fusion-evaporation. The strongest reaction channel is the 4 neutron evaporation which leads to ^{92}Zr evaporation residue. Other isotopes in the vicinity are produced as well, including ^{91}Zr and ^{93}Zr and some Y and Sr nuclei produced in processes involving charged particles evaporation. In the coincidence analysis level schemes for ^{91}Zr, ^{92}Zr and ^{93}Zr isotopes were established. Due to high reaction cross section the ^{92}Zr results are most complete and represent a significant extension of the existing structure data [2]. A total of 130 gamma transitions were placed into a level scheme that extends up to 16 MeV excitation energy. The angular distributions of strong transitions are now analysed to determine their multipolarities and make tentative spin assignments. We expect spins of the highest observed states of about 30 units. To extend further the high spin study in search for predicted interesting shape phenomena in medium mass Zr isotopes we plan to perform new experiment at higher bombarding energy.

References:

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2. G. Korschinek et al., Proc. Int. Conf. on Nucl. Structure, Tokyo, vol. 1 (1977) 326.