Nuclear Spectroscopy Study of the Isotopes Populated via Multi – Nucleon Transfer in the ⁹⁰Zr + ²⁰⁸Pb Reaction

Călin A. Ur

INFN - Padova

for the PRISMA - CLARA Collaboration



FUSION '06 - Venezia

Transfer Reactions with Heavy Ions

light ion reactions	heavy ion reactions
probe single particle properties (spectroscopic factors, shell model)	multiple transfers of nucleons (possibility to compare observables for multiple nn/pp/np pairs)
highly selective in energy and angular momentum transfer	population of high angular momentum and high excitation energy states
sensitive test for nucleon correlations (pairing, clusters)	evaporation effects, DIC, collective excitation



PRISMA - CLARA Setup

PRISMA



- Angular acceptances Solid angle Distance target - FPD Energy acceptance Resolving power Mass resolution Energy resolution Z resolution Count rate capability
- $\Delta \theta \approx \pm 6^{\circ} \Delta \phi \approx \pm 11^{\circ}$ $\approx 80 \text{ msr}$ 7 m $\pm 20\%$ p/ $\Delta p \approx 2000$ 1/200 (measured) 1/1000 (via ToF) $\leq 1/60$ (measured) up to 2x10⁵ sec⁻¹

CLARA



24 to 25 Clovers setup Efficiency ~ 3 % @ 1.3 MeV Peak/Total ~ 45 % Position θ = 103°-180° FWHM ~ 10 keV for E_y= 1.3 MeV @ v/c = 10%

The PRISMA Spectrometer



The Experiment

90Zr + 208Pb E_{LAB} = 560 MeV (TANDEM+ALPI) target ~ 300 µg/cm² PRISMA at θ_{LAB} = 61.25°



X-MCP



Ion Trajectory Reconstruction

A "raw" physical event is composed by a few parameters:position at the entrancex, $y \rightarrow (\theta, \phi)$ position at the focal planeX, Ytime of flightToFenergy and energy loss $\Delta E, E$ coincident γ -rays $E\gamma$

Result \rightarrow A, q, E, Z for the analyzed ions \rightarrow Doppler-corrected γ -ray spectra





Multinucleon Transfer



TKEL in Zr isotopes



TKEL in ⁹⁰Zr - Comparizon with GRAZING



TKEL - Excitation Energy Selection Tool



Multinucleon Transfer - High Spin States Population



Pairing Vibrational States in Zr Isotopes



Pairing Vibrational States in ⁹⁰Zr





P.E.Garrett et al., PRC68,024312(2003)

We have studied multinucleon transfer reactions in the 90 Zr + 208 Pb collision at an energy near the Coulomb barrier

Target – like products were detected with the high efficiency and high resolution spectrometer PRISMA that allowed for a complete set of experimental observables : Z,A yields, differential and total cross sections, Q-values, excited states population

Gamma – rays were detected with the CLARA array and Doppler – corrected according to the kinematical reconstruction of the events

GRAZING calculations account well for the experimental results situation in the chain of nuclei populated through pure neutron transfer (Zr isotopes)

Interesting studies on pair transfer degrees of freedom can be performed with the PRISMA spectrometer coupled to the CLARA gamma array