Evaporation residues spin distribution for $^{16}O+^{64}Zn$ and $^{32}S+^{48}Ti$ systems

Maninder Kaur[1], B.R. Behera[1], Gulzar Singh[1], Varinderjit Singh[1], N. Madhavan[2], S. Muralithar[2], S. Nath[2] , J. Gehlot[2], G. Mohanto[2], Ish Mukul[2], Davinder Siwal[3], Meenu Thakur[1], Kushal Kapoor[1], Priya Sharma[1], A. Jhingan[2], T. Varughese[2], Indu Bala[2], B.K. Nayak[4], A. Saxena[4] and M. B. Chatterjee[2]
[1]Department of Physics, Panjab University, Chandigarh - 160014, India.
[2]Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, India.
[3]Department of Physics and Astrophysics, University of Delhi - 110007, India.
[4]Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, India.
** email: manisaini153@gmail.com*

Introduction

The study of light particle evaporation spectra has been a powerful probe for inferring the properties of hot rotating compound nucleus. In some of these studies [1-3], the analysis of alpha and proton spectra through dynamical model code HICOL [4] predicted that the effective l_{max} value for fusion to take place in the case of symmetric system is low as compared to that predicted by the statistical model. The neutron spectra are explained by lowering the value of level density parameter *'a'* [3]. However, in most of the measurements existing in literature, consistent analysis has not been performed by taking other variables (cross-section, spin distribution etc.) into account. With this motivation we performed the Evaporation Residue (ER) cross-section (fusion cross-section) as well as ER spin distribution measurements for the asymmetric $^{16}O+^{64}Zn$ and symmetric $^{32}S+^{48}Ti$ reactions which populate the same compound nucleus (CN) ^{80}Sr. ER cross section provides the information of fusion dynamics, whereas ER spin distribution gives detailed information about the contribution of different partial waves. The objective of the present study is to compare the ER cross section and spin distribution of both the systems and explain the deviations observed in the light particle spectra [2]. Here we are reporting the preliminary results of the spin distribution measurement.

Experimental details

The experiment was carried out using Heavy ion reaction analyzer (HIRA) [5] + BGO multiplicity filter [6] at IUAC, New Delhi. Pulsed beams of ^{16}O with repetition rate of 2 µs, in the energy range from 66.6 to 91.9 MeV and ^{32}S with repetition rate of 1 µs, in the energy range from 95 MeV to 125 MeV were provided by 15UD pelletron accelerator [7]. Thin isotopic enriched targets of ^{64}Zn and ^{48}Ti having thickness of about 500 µg/cm^2 were used in the experiment. Two Si surface barrier detectors were mounted at $\pm 25^o$ with respect to beam direction for monitoring the beam. Spin distribution measurement was performed with 14 element BGO multiplicity array (7 detectors above and 7 below the target chamber), placed in a close geometry (at a distance of 24 mm from the target). The multiplicity filter covered 48% of the 4π sr solid angle. The focal plane detector system consisted of a MWPC of dimension 6”× 2”. A time-of-flight (TOF) spectrum was generated using anode of MWPC as start and RF signal, from beam pulsing system of beam, as stop. A two dimensional plot was generated using TOF and energy loss signal of MWPC. It provides a clean separation of ERs from other contamination.

Results

The γ-fold distribution was generated offline, from the 14 TDC signals, using CANDLE [8] software. The raw γ-fold spectrum was gated with ER events from the energy versus TOF spectrum for removing the non-ER events. Experimentally detected γ-fold distribution was converted to corresponding γ-multiplicity distribution using Van Der Werf prescription [9]. The multiplicity distribution was assumed to be a modified Fermi function of the form given as

$$P(M_\gamma)=\frac{2M_\gamma+1}{1+\exp(\frac{M_\gamma-M_{\gamma 0}}{\Delta M_\gamma})}$$

where $M_{\gamma 0}$ and ΔM_γ are two free parameters that are varied at each E_{lab} to obtain the best fit for fold distribution. Values of $M_{\gamma 0}$ and ΔM_γ were found by chi-square minimization of fold distribution. The comparison of fitted fold distribution and extracted multiplicity distribution for both the systems at E^* = 57 MeV is shown in Fig. 1. In Fig. 2 similar comparison is given for an approximate angular momentum matching of l_{max} = 37.6 ħ.

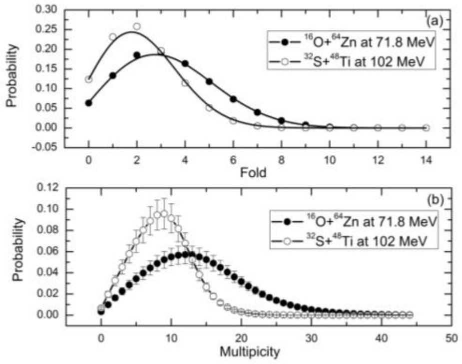

Fig. 1 (a) Comparison of fitted fold distributions and (b) extracted γ-multiplicity distribution for both the systems at E^* =57 MeV.

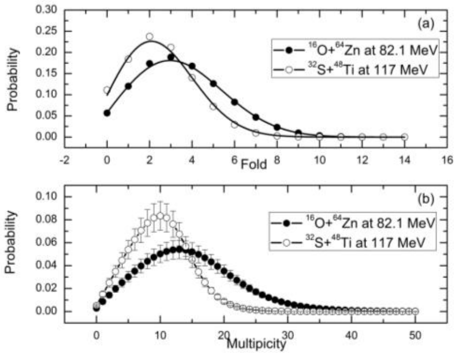

Fig. 2 (a) Comparison of fitted fold distribution and (b) extracted γ-multiplicity distribution for both the systems at l_{max} = 37.6 ħ.

The comparison of γ-multiplicity distribution for both the systems shows that the mean γ-multiplicity for the symmetric system is lowered as compared to the asymmetric system. Similar results are observed for the other energies also. From the multiplicity distribution we calculated the moments of distribution by given by the relation

$$\mu_i=\sum_0^\infty M^i P(M)$$

Fig. 3 shows the γ-multiplicity as a function of excitation energy for both the systems.

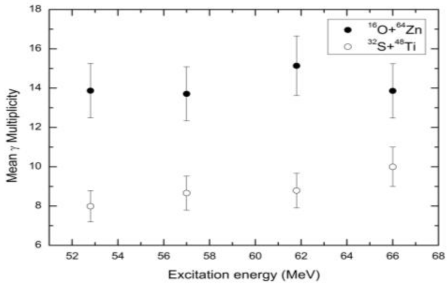

Fig. 3 Comparison of mean γ-multiplicity for the two systems.

These observations again indicate that for the symmetric system the mean γ-multiplicity is less as compared to the asymmetric system.

References

[1] D.K. Agnihotri *et al.*,Phy. Lett. **307** B, 283 (1993).

[2] J. Kaur *et al.*, Phy. Rev. C **70**, 017601 (2004).

[3] A. Kumar *et al.*, Phy. Rev. C **70**, 044607 (2004).

[4] H. Feldmeier, Rep. Prog. Phys. **50**, 915 (1987).

[5] A.K. Sinha, *et al.*, Nucl. Inst. and Meth. A **339**, 543 (1994).

[6] S. Muralithar, DAE symp. on Nucl. Phys. **34** B, 417 (1991).

[7] G. K. Mehta and A. P. Patro, Nucl. Instr. and Meth. A **268**, 334 (1988).

D. Kanjilal *et al.*, Nucl. Inst. and Meth. A **328**, 97 (1993).

[8] B.P. Ajith Kumar *et al.*, DAE Symp. Nucl. Phys. **44** (2001).

[9] Van Der Werf, Nucl. Instr. and Meth. **153**, 221 (1978).