Study of fission dynamics of ^{260}Rf nuclei

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Introduction

Fusion-fission (FF) and quasi-fission (QF) act as a benchmark processes to understand the reaction dynamics and the evolution of different degrees of freedom during the formation of a compound nucleus (CN). Experimental probes such as fission fragment angular distribution, mass distribution (MD), mass-energy distribution (MED) and mass-gated neutron multiplicity are used to explore the properties of these processes. Neutron emission is the most prominent and commonly used probe for the systems where MD and MED are unable to discriminate between QF and FF [1] processes in the reaction dynamics of heavy/near super-heavy elements. That said, we have studied the MD, MED and mass-angle correlations, average neutron multiplicity, mass-gated, and energy-gated neutron multiplicity, and neutron angular distributions for the ^{28}Si + ^{232}Th reaction populating the near super-heavy nuclei ^{260}Rf at the laboratory energy ranging from 160 MeV to 200 MeV. The chosen reaction offers an opportunity to compare the fission dynamics of ^{260}Rf with that of the different isotopes of Rf nuclei, and to study the role of entrance channel deformation and shell effects on the QF and FF processes. In the present paper, we are reporting the results from an experiment performed for the reaction ^{28}Si + ^{232}Th using the NAND array [2] at Inter University Accelerator Centre (IUAC), New Delhi. The details of the experimental setup employed for these studies are given in [3].

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Data Analysis and Results

The collected data has been analyzed using a framework based on the ROOT software package and the analysis strategy together with the analysis techniques used for the extraction of mass distribution and neutron multiplicity are available in [4, 5].

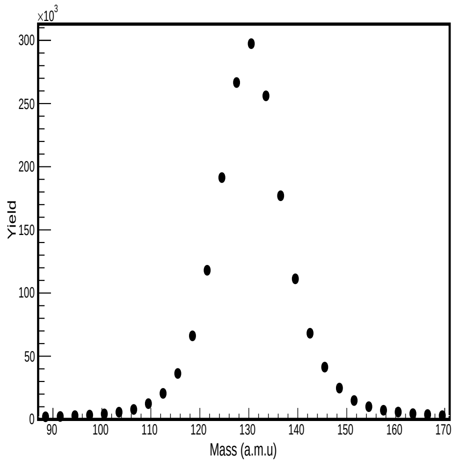

FIG. 1: Mass distribution spectrum for the reaction ^{28}Si + ^{232}Th at the laboratory energy of 160 MeV.

The obtained mass distribution for the reaction ^{28}Si + ^{232}Th at the laboratory energy of 160 MeV (using time-of-flight technique) is shown in Fig. 1. The extracted FWHM of MD is 8 a.m.u., which is significantly smaller than the value reported for the ^{48,50}Ti + ^{208}Pb systems populating ^{256,260}Rf nuclei [4, 6]. This huge difference in mass width indicates that fusion-fission contributions in the ^{28}Si + ^{232}Th is more than that for the 48Ti induced systems. This is mainly due to the large entrance channel charge product (Z1Z2, where Z1 and Z2 are the atomic numbers of projectile and target nuclei respectively) for the ^{48,50}Ti + ^{208}Pb systems. These entrance channel effects have also been observed in our neutron multiplicity results [3]. These results suggest that the entrance channel charge product effects play a dominant role than the entrance channel deformation for the present study.

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References

[1] M.G. Itkis *et al.*, Nucl. Phys. A **734**, 136 (2004).

[2] P. Sugathan *et al.*, Pramana **83**, 807 (2014).

[3] Meenu Thakur *et al.*, JPS Conf. Proc. **32**, 010005 (2020).

[4] Meenu Thakur *et al.*, Eur. Phys. J. A **53**, 133(2017).

[5] Meenu Thakur *et al.*, Phys. Rev. C **98**, 014606 (2018).

[6] S. Appannababu *et al.*, Phys. Rev. C **94**, 044618 (2016).