To investigate the impact of N/Z on pre-scission neutron multiplicity for ^{206}Rn*

Punit Dubey[1],* Mahesh Choudhary[1], Namrata Singh[1], Mahima Upadhyay[1], Shweta Singh[1], Utkarsha Mishra[1], Sriya Paul[1], N. Saneesh[2], Mohit Kumar[2], Rishabh Prajapati[2], K. S. Golda[2], Akhil Jhingan[2], P. Sugathan[2], Raghav Agarwal[3], Kiran[3], and Ajay Kumar[1]†

[1]*Department of Physics, Banaras Hindu University, Varanasi - 221005, INDIA*

[2] *Inter-University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, INDIA and*

[3]*Department of Physics, Panjab University, Chandigarh - 160014, INDIA*

Introduction

The published research indicates that the nuclear fusion-fission dynamics are heavily influenced by factors such as the entrance channel mass asymmetry (α), the shell effect, and the N/Z ratio. Researchers have conducted experimental and theoretical studies [1–11] to determine the influence of these characteristics on fusion-fission dynamics. We found that the most effective method for determining the relationship between these parameters in fission dynamics is pre-scission neutron multiplicity (M_{pre}). Furthermore, a prior investigation revealed that as the N/Z ratio of the system rises, there is a corresponding increase in neutron multiplicity [11]. In the present work, we have calculated the neutron multiplicities of the compound nucleus(CN) of ^{206}Rn.

Experiment details

The experiment was carried out using 15UD Pelletron+LINAC accelerator facility of IUAC, New Delhi where pulsed beam of ^{28}Si in the energy range of 146-180 MeV was bombarded on ^{178}Hf targets resulting in the formation of the compound nuclei ^{206}Rn. The binary fragments resulting from the fission of the ^{206}Rn CN were detected using two Multi-Wire Proportional Counters (MWPC). These counters were positioned 70° apart from each other on opposite sides of the beam direction. The dimensions of the counters were 20 cm x 10 cm. The neutron detector array, NAND, utilized 5 in. × 5 in. BC501A organic scintillators to detect fast neutrons generated from fission fragments (FF) and CN [12].

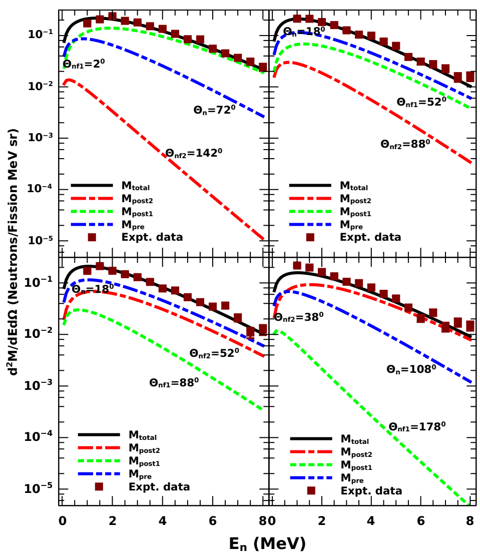

FIG. 1: Experimental double differential neutron multiplicity spectra (solid square) for ^{28}Si+^{178}Hf reaction for different neutron detectors of the reaction plane.

The neutron multiplicity of CN (M_{pre}) and FF (M_{post}) were determined using the moving source fitting method. Pulse shape dis-

*Electronic address: punitdubey@bhu.ac.in
†Electronic address: ajaytyagi@bhu.ac.in

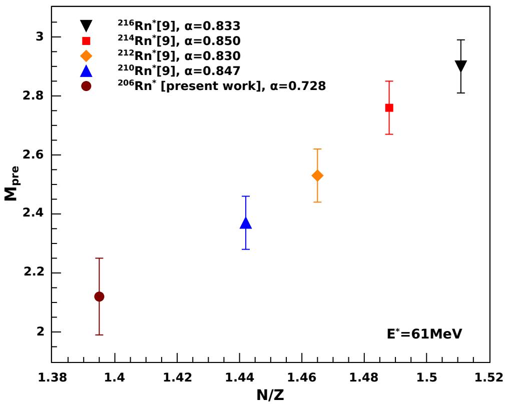

FIG. 2: Variation of pre-scission neutron multiplicity w.r.t. N/Z ratio for different CN of Rn at E*=61 MeV.

crimination technique based on zero cross-over were used to distinguish the fast neutrons released during fission events from gamma-ray backgrounds. The energy spectra of neutrons at various angles relative to the CN and FF directions were analyzed using the Watt formula, with the goal of reducing the chi-square value.

Results and Discussion

Fig. 1 illustrates the double differential neutron multiplicity spectra that have been adjusted to fit the data, as well as the individual contributions from various neutron sources. The spectra are analyzed for neutron energy in the range of 1-8 MeV. The data was simultaneously fitted for the 16 neutron detectors located in the reaction plane (7^{th} ring). The data clearly demonstrates that the contributions of different sources to the shape vary significantly depending on the relative angle between the neutron sources and the detectors. The values of average M_{pre}, M_{post}, T_{pre}, and T_{post} were obtained by fitting 16 energy spectra for the reaction plane neutron detectors using Watt's expression for the ^{28}Si+^{178}Hf reaction at E*=61 MeV. These data are presented in Table 1.

Fig. 2 presents a comparison between the N/Z ratio and M_{pre} for various isotopes of Rn. The

TABLE I: Experimentally calculated results for ^{28}Si+^{178}Hf reaction forming ^{206}Rn at E*=61 MeV.

	E*	M_{pre}	M_{post}	M_{total}
^{206}Rn*	61.00	2.12±0.13	3.26±0.07	5.38±0.14

data shows a linear relationship, regardless of the variation in entrance channel mass asymmetry (α). An in-depth investigation is ongoing to calculate the average neutron multiplicities at various incident energies. These results will be compared with a theoretical dynamical model and presented during the conference.

Acknowledgments

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