



Contribution ID: 38

Type: not specified

An observation of suppressed pre-scission α -Particle emission in the pre-actinide region

Pawan Singh ^{1,2}, Y. K. Gupta ^{1,2}, G. K. Prajapati ^{1,2}, N. Sirswal ^{1,2}, B. N. Joshi ^{1,2}, Harshad Vyas ^{1,2}, K. Ramachandran ¹, and V. V. Desai ³

¹ Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai 400085, India

² Homi Bhabha National Institute, Anushaktinagar, Mumbai 400094, India

³ SIES College of Arts, Science and Commerce, Sion, Mumbai - 400022, India

Since the discovery of nuclear fission by Hahn and Strassmann in 1939, it has remained a subject of sustained research interest. Nuclear fission is a fascinating example of large-scale rearrangement of strongly interacting nucleons within a finite many-body system. Despite decades of extensive experimental and theoretical efforts, several aspects of the fission process are still not fully understood. In this context, the emission of light charged particles serves as a potential probe to get fine details about the subtle aspects of the process. It offers valuable insight into the interplay between nuclear structure, dissipation, and collective motion.

α -particle multiplicities spectra were measured for the reactions $^{12}\text{C}+^{209}\text{Bi}$ at a beam energy of 75 MeV and $^{19}\text{F}+^{209}\text{Bi}$ at 99 MeV, leading to the formation of the compound nuclei $^{221}\text{Ac}^*$ and $^{228}\text{U}^*$, respectively. The experiments were carried out at the BARC-TIFR Pelletron/LINAC facility, Mumbai, using a dedicated detector setup optimized for the detection of light charged particles in coincidence with fission fragments. After correcting for random coincidences, the normalized α -particle multiplicity spectra were obtained by dividing the coincidence energy spectra by the total number of fission single events.

The Moving Source Disentangling Analysis (MSDA) was then employed to calculate the contributions from different emission stages, namely pre-scission, near-scission, and post-scission emissions.

A pronounced difference is observed in the pre-scission α -particle multiplicities for the two systems.

The multiplicity associated with the $^{221}\text{Ac}^*$ compound nucleus is nearly an order of magnitude lower than that observed for the $^{228}\text{U}^*$ compound nucleus, despite the excitation energies being comparable (37.4 MeV for $^{221}\text{Ac}^*$ and 40.2 MeV for $^{228}\text{U}^*$). This substantial reduction in α -particle multiplicity cannot be explained solely by the modest difference in excitation energy.

To quantitatively understand this behavior, statistical model calculations were performed using the JOANNE2 code. The model incorporates deformation-dependent particle binding energies and transmission coefficients and treats the fission process in two distinct stages: from the compound nucleus to the saddle point and from the saddle point to scission. The calculated α -particle multiplicities are in good agreement with the experimentally extracted values. Thus, a suppression of pre-scission alpha particle multiplicity in the pre-actinide region at a similar excitation energy of around 40 MeV is established from experimental and theoretical investigations.

Detailed results will be presented during the workshop.

Type of contribution

Regular Abstract

Primary author: SINGH, Pawan (Bhabha Atomic research centre, Mumbai, India)

Presenter: SINGH, Pawan (Bhabha Atomic research centre, Mumbai, India)

Session Classification: session 10 (Chair: C. Simenel)