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Deviations from Hauser-Feshbach behaviour in evaporation chains in light heavy-ion collisions

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In the framework of the NUCL-EX activities, we extended the investigation on the decay of light nuclei at excitation energies above particle emission thresholds, by performing exclusive fusion-evaporation measurements. The 12O+12C reaction was investigated at three different bombarding energies, namely 90, 110 and 130 MeV.
For complete fusion, such reactions lead to a fused 28Si system respectively at 55, 63 and 72 MeV excitation energy. Therefore, we were able to explore the energy dependence of this autoconjugate system and to better put into evidence the role of non-statistical effects, clearly observed in our previous studies on other central ligh-ion collisions (i.e. 12C+12C, 14N+10B and 12C+13C)
The employed apparatus was composed by the coupling of GARFIELD and RingCounter detectors, in operation at the LNL (Legnaro National Laboratories of INFN). This apparatus has large coverage (about 75% of the total solid angle) and the capability to measure the charge, the energy and the emission angle of nearly all the charged reaction products, allowing for an excellent discrimination of the different reaction mechanisms.
Using the Hauser-Feshbach statistical theory of Compound Nucleus (CN) decay, the detailed output of a fusion-evaporation reaction is uniquely predicted under the knowledge of nuclear ground state properties and level densities. Two decay codes were used to compare the experimental data. The first one was a Hauser-Feshbach Monte-Carlo developed by the NUCL-EX collaboration and particularly optimized for light systems (HFl) by explicitly including the experimentally measured particle unstable levels from the archive NUDAT2. The second one was the GEMINI++ code, widely used to describe fusion-evaporation reactions.
One important result of the previously studied reactions was a clear deviation of the experimental Branching Ratio (BR) in the α-emission channels in coincidence with an even-Z evaporation residue with respect to the statistical decay model. These deviations were attributed to structure or pre-compound effects. Specifically, they were related to the α-cluster nature of the issued CN or of the reaction partners which persisted at high excitation energies.
The preliminary results obtained for the 12O+12C further confirm this behavior for even-Z evaporation chains and also highlight an energy dependence for the BR deviations which tend to grow with increasing bombarding energy. Moreover, an anomalous high BR was observed also for an odd-Z channel when compared to statistical code predictions at 130 MeV.

Selected session

Nuclear Structure, Spectroscopy, and Dynamics

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