Probing SHN structure and stability – synthesis and decay studies *

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Decay spectroscopy after separation (DSAS) is an efficient tool to study nuclear structure features of heaviest nuclear species [1, 2], like single particle trends towards the predicted next spherical shell closures beyond ^{208}Pb, and deformation and exotic shapes, leading also to the formation of meta-stable states [3], like K-isomers.

In particular, the unpaired nucleon in odd-even and even-odd nuclei, like ^{249,251}Md [4] or ^{255}No [5,6], can serve as efficient probe to study these meta-stable states and other nuclear structure effects effects. While for even-even isotopes often 2-quasi-particle excitations across a shell gap lead to high K-numbers, the meta-stable states in odd-mass nuclei are formed as 3-quasi-particle or even 5-quasi-particle states [6], where high K values are produced by 2- and 4-quasi-particle excitations coupled to the odd un-paired nucleon. In this way, highest values of K are generated close to the deformed shell gaps for neutrons and protons at $N = 152$ and $Z = 100$, making K-isomers a systematic feature in that region of the Segré chart, and a sensitive probe for deformation developing towards the spherical superheavy nuclei (SHN).

Complex configurations of low-lying states in heavy nuclei can also have consequences for decay mode competition and nuclear stability, providing indications that might also be relevant for the location of the long-searched-for *"island of SHN with enhanced stability"*. One example is the observation of low excitation energies for single-particle states originating from orbitals which are supposed to define the shell gaps for spherical SHN, like in the case of the ^{247}Md $\rightarrow$ ^{243}Es decay [7]. Here the decay mode competition between SF and α decay resulted in largely different SF-α branching ratios for $^{247g.s.}$Md and ^{247m}Md.

The understanding of the reaction mechanism governing heavy collisions employed for the synthesis of the heaviest nuclei, despite decades of experimental and theoretical efforts, is still a challenging task [8]. Being a fundamental topic by itself, mastering reaction theory and producing reliable cross section predictions are essential for a successful experimental program. Detailed nuclear structure studies of the heaviest nuclei as well as the synthesis of SHE are presently still hampered by the limited efficiencies of the existing experimental facilities. To overcome this restriction, among other facilities online since recently or planned for the future worldwide, the linear accelerator facility SPIRAL2 at GANIL in Caen, France [9], equipped with the versatile separator spectroscopy set-up S^3 [10] will be operational shortly.

This presentation will report on slected aspects of the state of the art of DSAS for SHN, and the plans envisaged at GANIL/SPIRAL2 and S^3.

[1] D. Ackermann and Ch. Theisen, Phys. Scripta **92**, (2017) 083002.
[2] D. Ackermann, arXiv:2501.04053 [nucl-ex].
[3] D. Ackermann *et al.*, Eur. Phys. J. ST **233**, (2024) 1017.
[4] T. Goigoux *et al.*, Eur. Phys. J . A **57**, (2021) 321.
[5] A. Bronis *et al.*, Phys. Rev. C **106**, (2022) 014602.
[6] K. Kessaci *et al.*, Phys. Rev. C **110**, (2024) 054310.
[7] F.P. Heßberger *et al.*, Eur. Phys. J. A **58**, (2022) 11.
[8] D. Boilley et al., PRC 94, 034616 (2016)
[9] E. Petit - SPIRAL2 coll., Proc. of NA-PAC2016, Chicago, IL, USA, TUA1IO02, 2016.
[10] F. Dechery et al., Eur. Phys. J. A **51**, 66 (2015).

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