

# **$\gamma$ -spectroscopy combining isotopically identified fragments and high fold $\gamma$ -rays in Nb isotopes - first observation of 1 and 2 phonon $\gamma$ -vibrational bands in odd-odd nucleus**

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The nuclear structure of neutron-rich nuclei around  $A \sim 100$  shows shape transitions and large deformations. Among others, these include ellipsoidal oscillation of the shape ( $\gamma$ -vibrations). One-phonon  $\gamma$ -bands are observed in numerous deformed nuclei, however, observations of two or higher-order phonon  $\gamma$ -bands are rare. While the even- $Z$  nuclei have been well investigated, the spectroscopy of odd-odd nuclei in this region can provide deeper insights into our understanding. As part of a study of the evolution of the structure of even-odd and odd-odd neutron-rich Nb isotopes, the structure of  $^{104}\text{Nb}$  was investigated in detail. The Nb nuclei were populated in fission reactions and measured using gamma-ray spectroscopy in two complementary ways using a) isotopically identified fragment produced in beam fusion and transfer induced fission in the  $^{238}\text{U}+^9\text{Be}$  system using the VAMOS++ and the AGATA spectrometer and b) high statistics  $\gamma$ - $\gamma$ - $\gamma$  and  $\gamma$ - $\gamma$ - $\gamma$ - $\gamma$  fold data from the spontaneous fission of  $^{252}\text{Cf}$  using GAMMASPHERE. The talk will discuss the complementarity of the two methods necessary for studying neutron-rich nuclei at high spin, especially for odd-odd nuclei. The data are then systematically compared with neighboring multi-phonon  $\gamma$ -vibrational bands to address the interesting observation for the first time of multi-phonon vibrational bands in  $^{104}\text{Nb}$ .

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