News on High-ℓ Proton Emission from ^{53m}Co and ^{54m}Ni

D. Rudolph[1], J. Giovinazzo[2], T. Roger[3], L.G. Sarmiento[1], B. Blank[2], B.A. Brown[4], A. Kankainen[5], and on behalf of the GANIL E690 and JYFL I199 experiment collaborations

[1] *Department of Physics, Lund University, SE-22100 Lund, Sweden*

[2] *Laboratoire de Physique des deux Infinis de Bordeaux, CNRS/IN2P3 - Université de Bordeaux, F-33170 Gradignan, France*

[3] *Grand Accélérateur National d'Ions Lourds, CEA/DRF-CNRS/IN2P3, F-14076 Caen, France*

[4] *Department of Physics and Astronomy and National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824-1321, USA and*

[5] *Accelerator Laboratory, Department of Physics, University of Jyväskylä, FI-40014 University of Jyväskylä, Finland*

Along the $N = Z$ line between $^{40}_{20}\mathrm{Ca}_{20}$ and $^{56}_{28}\mathrm{Ni}_{28}$, strongly attractive two-body matrix-elements between neutron and proton $f_{7/2}$ particles (or holes) give rise to spin-gap isomers with rather high angular momenta. Examples near ^{56}Ni are $I^\pi = 7^+$ in $^{54}_{27}\mathrm{Co}_{27}$, $I^\pi = 12^+$ in $^{52}_{26}\mathrm{Fe}_{26}$, or $I^\pi = 10^+$ in case of the $A = 54$ ($^{54}_{26}\mathrm{Fe}_{28}$ and $^{54}_{28}\mathrm{Ni}_{26}$) as well as $I^\pi = 19/2^-$ in case of the $A = 53$ ($^{53}_{26}\mathrm{Fe}_{27}$ and $^{53}_{27}\mathrm{Co}_{26}$) 'mirror isomers', respectively.

For the neutron-deficient mirror partners, ^{53m}Co and ^{54m}Ni, Q values allow for intriguing competition between electromagnetic decays ($E2$ and/or $E4$), β-decay branches, and proton radioactivity. In fact, the observation of a weak $\ell = 9$ proton-emission branch from the 3174-keV ^{53m}Co isomeric state into the ground state of ^{52}Fe marked the discovery of proton radioactivity in atomic nuclei in 1970 [1,2].

Combining data taken with the TASISpec decay station at the Accelerator Laboratory of the University of Jyväskylä, Finland, and the ACTAR TPC device on LISE3 at GANIL, France, allowed to fully assess the proton-emission branches of ^{53m}Co [3]. In the same ACTAR TPC experiment, both proton-emission branches of ^{54m}Ni were determined [4,5]. The new experimental results were compared to cutting-edge shell-model and barrier penetration calculations for these (very) high-ℓ protons with $\ell = 5$, 7, and 9, all (very) far beyond the $\mathcal{N} = 3$, $f_{7/2}$ shell [3,4].

Further, the completed decay pattern of ^{54m}Ni allowed to derive reduced transition strengths, $B(E2; 10^+ \rightarrow 8^+)$ and $B(E4; 10^+ \rightarrow 6^+)$, for the two competing γ-ray transitions from ^{54m}Ni. By means of a comparison with their well-known 'mirror transitions' in $T_z = +1$ ^{54}Fe, effective charges for $E4$ transitions near $N = Z$ ^{56}Ni could be suggested [6].

The presentation will provide an overview of the experiments, the results, and the nuclear structure interpretations.

[1] K.P. Jackson *et al.*, Phys. Lett. B **33** (1970) 281.
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[3] L.G. Sarmiento *et al.*, Nature Commun., in press.
[4] J. Giovinazzo *et al.*, Nature Commun. **12** (2021) 4805.
[5] J. Giovinazzo *et al.*, Nucl. Instr. Meth. A **1042** (2022) 167447.
[6] D. Rudolph *et al.*, Phys. Lett. B **830** (2022) 137144.