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New Results on the Nuclear Two-Photon Decay

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The nuclear two-photon or double-gamma (2γ) decay is a second-order electromagnetic decay process whereby a nucleus in an excited state emits two gamma rays simultaneously. It proceeds via the virtual excitation of higher-lying intermediate states. Compared to first-order decay pathways, such as single photon emission or internal conversion, the two-photon decay rate is very small. Ideal cases for this search are $0^+ \rightarrow 0^+$ transition where single photon emission is prohibited. However, the only cases where the 2γ decay of a was successfully observed using γ-ray spectroscopy are ^{16}O, ^{40}Ca and ^{90}Zr [1, 2], where the high energy of the transitions is favourable for the 2γ branch.

At lower energies the 2γ branch becomes prohibitively small for γ-ray spectroscopy (<10^{-6}). We have therefore combined the isochronous mode of a storage ring with Schottky resonant cavities to perform Schottky + Isochronous Mass Spectrometry (S+IMS) in order to study exotic decays of short-lived states at the Experimental Storage Ring at GSI. This novel technique allowed us to conduct the first direct measurement of the half-life for the nuclear two-photon decay branch of the 0^+ isomer in ^{72}Ge [3]. The obtained mass resolving power enables future experiments on nuclear isomers with excitation energies as low as ~100 keV and half-lives as short as ~10 ms. In addition, first results from experiments on ^{98}Zr and ^{98}Mo should also be presented.
[1] J. Schirmer et al., Phys. Rev. Lett. 53, 1897–1900 (1984).
[2] J. Kramp et al., Nuclear Physics A 474, 412–450 (1987).
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