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Nuclear excitation by electron capture with electron vortex beams for isomer depletion

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Nuclear isomers can store a large amount of energy over long periods of time, with a very high energy-to-mass ratio. Dynamical external control of such nuclear states has proven so far very challenging, despite ground-breaking incentives for a clean and efficient energy storage solution. Here, we describe a protocol to achieve the dynamical control of the isomeric nuclear decay via the process of nuclear excitation by electron capture [1] with electron vortex beams whose wavefunction has been especially designed and reshaped on demand [2]. This could lead to the controlled release of the nuclear energy. We show theoretically that the use of tailored electron vortex beams can increase the isomer depletion by 2 to 6 orders of magnitude compared to so far considered depletion mechanisms and provides a handle for manipulating the capture mechanism [2].

[1] Y. Wu, C. H. Keitel, A. Pálffy, Phys. Rev. Lett. 122, 212501 (2019).

[2] Y. Wu, S. Gargiulo, F. Carbone, C. H. Keitel, A. Pálffy, arXiv: 2107.12448.

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