Physicists observe excited states in lanthanum-120

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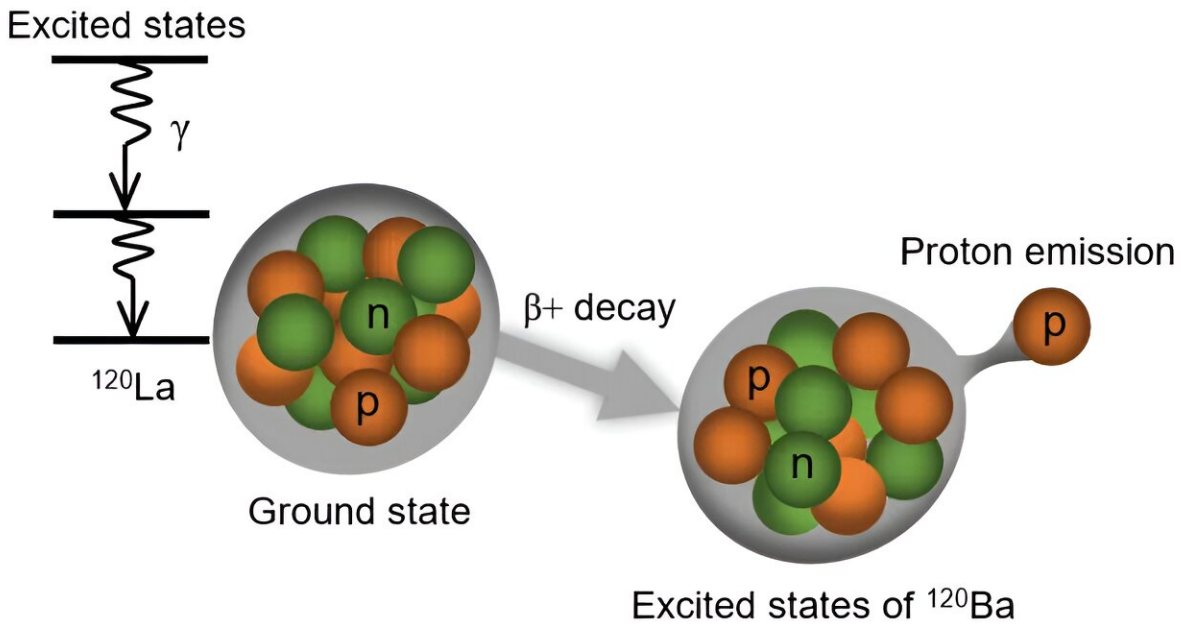

The deexcition and decay mode of lanthanum-120. Credit: Prof. Lyv

For the first time, physicists have observed excited states in the very neutron-deficient odd-odd nucleus, lanthanum-120. The study, published in *Physics Letters B*, was conducted by researchers from the Institute of Modern Physics (IMP) of the Chinese Academy of Sciences, and their collaborators from France, Finland, South Africa and other countries.

As medium-heavy nuclei approach the N=Z line, it is predicted that the proton-neutron interaction will be enhanced, having a measurable impact on the structure of excited states. This may also be accompanied by shape changes of nuclei, which exhibit non-spherical shapes, such as "rugby ball" (prolate), "pancake" (oblate), "pear" (octupolar), or "kiwi" (triaxial) shapes.

Lanthanum-120 is a rare β-delayed proton emitter discovered in 1984. Due to its extremely low production cross-section, separating and identifying lanthanum-120 has posed a great challenge. Over the past 40 years, experimental physicists have not been able to successfully measure the excited states of lanthanum-120.

"It is crucial to experimentally measure the excited states to explore the underlying mechanism of the structure evolution in the extremely proton-rich lanthanum nuclei," said Assoc. Prof. Lyv Bingfeng at IMP, one of the corresponding authors of the study.

The researchers utilized a state-of-the-art setup composed of a mass separator and high-efficiency gamma detector arrays to search for the excited states in lanthanum-120, at the accelerator laboratory of the University of Jyvaskyla, Finland. They then established the level structure of lanthanum-120.

The researchers found that the spin at which the energies of odd- and even-spin cascades of gamma rays of lanthanum-120 are crossing follows the systematic trend. Moreover, they discovered that the transition probabilities exhibit a strikingly different pattern, with a significant staggering between odd and even spins, which is distinct from neighboring nuclei.

"Our data, combined with theoretical models, suggest that lanthanum-120 exhibits a pronounced triaxial deformation. This study

also indicates that the proton-neutron interaction plays an essential role in describing the structure of odd-odd nuclei close to the proton drip line in the A≈120 mass region," said Costel Petrache from the University of Paris-Saclay, France, another corresponding author.

More information: P.M. Jodidar et al, First observation of excited states in 120La and its impact on the shape evolution in the A ≈ 120 mass region, *Physics Letters B* (2024). DOI: 10.1016/j.physletb.2024.138806

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