Observation of unexpectedly deformed neutron-rich magnesium nuclei prompts rethink of nuclear shell structure

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Although much is known about atoms and their nuclei, scientists continue to make surprising discoveries as they probe the properties of some of the more exotic isotopes. Pieter Doornenbal from the RIKEN Nishina Center for Accelerator-Based Science (RNC) and co-workers have made another such discovery with the observation that magnesium nuclei with a large number of neutrons appear to lose the nuclear shell structure that has become fundamental to our understanding of the nucleus.

The beams of magnesium nuclei were produced by first bombarding a high-energy beam of calcium nuclei against a thin beryllium target. The collision created a multitude of different nuclei that were then screened using magnetic fields to select precursor nuclei—aluminum-37, aluminum-39 and silicon-40. The desired magnesium nuclei were then obtained by bombarding the precursor nuclei against a carbon target to knock out additional nucleons.

The researchers probed the shape of the magnesium nuclei by measuring the high-energy electromagnetic waves that they emit. By comparing these results to theoretical calculations and previous experimental work, the team inferred a large ‘island’ of deformation in the isotope chart for neutron-rich nuclei with 20 to 28 neutrons. "This behavior is also expected to occur for larger magic numbers," says Doornenbal. "However, we do not..."
yet have the experimental tools to study it in these regions."


Provided by RIKEN


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