A Franco-Japanese experiment in search of nuclear magic numbers

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A Franco-Japanese research team including researchers from CEA, CNRS, Université Paris-Sud and Université de Strasbourg has designed an experiment to study highly unstable atomic nuclei. Initial results are published in the 3 November 2015 issue of *Physical Review Letters*. This research advances our understanding of the strong interaction, one of the four fundamental forces of nature, which governs the behavior of matter within atomic nuclei.

Our physical world is governed by four fundamental forces: gravitation, electromagnetism, the weak interaction responsible for radioactive decay, and the strong interaction holding together subatomic particles. The strong nuclear force, derived from the strong interaction, binds nucleons (protons and neutrons) together within atomic nuclei. It is responsible for complex quantum phenomena and the formation of atoms, from lightest to heaviest, in stars.

Certain nuclei with specific numbers of neutrons and protons are particularly stable. Nuclear physicists refer to them as 'magic number nuclei'. Understanding the mechanisms responsible for this relative stability and providing a universal description of atomic nuclei remains a challenge for modern theories.

EU framework program and one-of-a-kind Japanese accelerator facility

In order to address this challenge, a new device called MINOS has been developed to measure the spectroscopic properties (i.e. energy levels) of unstable nuclei. This new system is operational since 2014 at the RIKEN Nishina Center's Radioactive Isotope Beam Factory (RIBF), the most advanced facility in the world for producing neutron-rich nuclei and studying previously inaccessible nuclei.

Unraveling the mystery of magic numbers

After 5 years of technical development at CEA and analysis of the first experimental campaign results, the Franco-Japanese research team has just published a first set of results. The first experiment enabled the study of the most neutron-rich chromium and iron nuclei accessible to date. The initial results published in *Physical Review Letters* question the 'magic' character of N=50 (number of neutrons) for neutron-rich nuclei in this region. MINOS will continue to be used for other experiments, and a wealth of new results is expected. In particular, these experiments should contribute to solving the mystery of magic numbers for unstable nuclei by improving our understanding and modeling of the atomic nucleus.

Provided by CEA

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