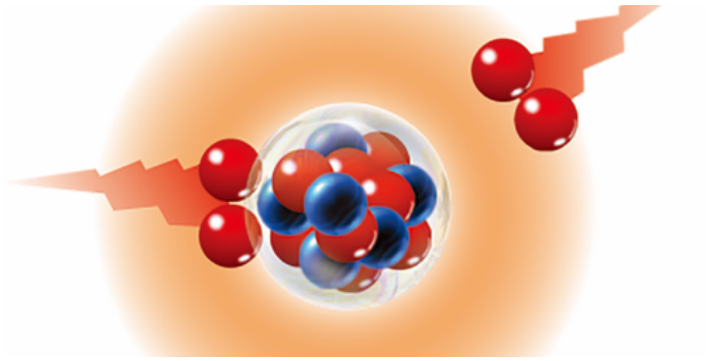
New Unstable Nucleus Detected

Experimental detection of the unstable nucleus magnesium-18 hints at a weakening of the so-called magic number for the closed shell of eight neutrons.

By **Erika K. Carlson**

Atomic nuclei are typically only stable when they have certain ratios of protons and neutrons. Unstable nuclei, most often those with a large imbalance of protons and neutrons, can appear in nuclear reactions but decay rapidly. Now, Yu Jin of Peking University, China, Chenyang Niu of Michigan State University, and colleagues have experimentally detected the previously unseen unstable nucleus magnesium-18 [**1**]. Their finding offers a new opportunity to test and refine models of nuclear structure.

In their experiments, the team aimed a beam of magnesium-20 nuclei, which contain 12 protons and 8 neutrons, at a target. The impact stripped two neutrons from some of the nuclei, producing magnesium-18. Those magnesium-18 nuclei promptly emitted four protons, decaying into oxygen-14, a process the team detected using a spectrometer capable of spotting oxygen-14 nuclei from the remaining magnesium-20 nuclei. They also detected the emitted protons, which were deflected from the beam at an angle of between 1° and 10°, and they measured the energies of those protons. Those measurements allowed the team to infer the energies of the magnesium-18 nuclei prior to decay.



Credit: S. M. Wang/Fudan University

The team's observation is only the second observation of the decay of nuclei via the emission of four protons. From their measurements of the decayed particles' energies, they concluded that they had likely produced magnesium-18 nuclei both in one of its excited states and in its ground state. The excitation energy that they measured for the detected excited state was greater than that of the equivalent state of magnesium-20, something that can happen when the binding energies of "magic number" closed shells are weakened (see **Synopsis: The Limits of a Closed Shell**). The team says that further investigation will be needed to find out if this weakening is the cause of magnesium-20's lower excitation energy or if it is something else.

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REFERENCES

1. Y. Jin *et al.*, "First observation of the four-proton unbound nucleus ^{18}Mg," **Phys. Rev. Lett. 127, 262502 (2021).**