Discovery could challenge established theory of the nucleus

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(PhysOrg.com) -- By analyzing data from experiments performed earlier this decade at the Oak Ridge Electron Linear Accelerator (ORELA), physicists have made observations that seem to conflict with the widely accepted theory of the nucleus.

In 2002, Paul Koehler, a physicist at Oak Ridge National Laboratory (ORNL) in Tennesse, and others were measuring neutron resonances in four types of platinum isotopes. These resonance patterns - which are the energies at which the nucleus of a platinum isotope absorbs neutrons - are affected by the motion of the protons and neutrons inside the nucleus. These motions are thought to be chaotic, at least according to random matrix theory, which is used to determine the behavior of large nuclei. However, in a recent study, Koehler and his colleagues found that the protons and neutrons seem to move in a collective way that can't be explained by any known model of nuclear structure.

“The new results suggest that the roughly 200 nucleons inside the platinum nuclei studied act in unison to exhibit regular rather than chaotic properties,” according to a news article from ORNL's website. “Given the relatively high energy and large number of nucleons involved, such collective behavior is totally unexpected and unexplained.”

The researchers say that their results reject the random matrix theory for this data with a 99.997% probability. But to confirm their claim, the scientists need to perform further experiments on the nuclei of other elements besides platinum, which could verify that the discovery is not simply due to an unusual property of platinum nuclei.

However, the problem is that ORELA has been closed due to budget cuts , and is not scheduled to reopen any time soon. The US Department of Energy has said that other research projects are a higher priority for the field of nuclear science. According to Koehler, there is one other place in the world where similar measurements could be made, which is the Geel Electron Linear Accelerator (GELINA) in Geel, Belgium. Here, the physicists could also repeat early experiments regarding random matrix theory performed in the 1970s at Columbia University, and see if the results hold up to modern instruments and analysis methods.

As Koehler explained, resolving the issue could have implications for nuclear reactors. Scientists rely on random matrix theory to estimate the probability of escaping neutrons colliding with nuclei, and use these estimates to determine how much shielding is needed for nuclear reactors and stockpiles. Although some extra shielding is typically added, if more nuclear reactors are going to be built in the future, having an accurate estimate for shielding protection would be an important safety standard.

More information: P. E. Koehler, et al. “Anomalous Fluctuations of s-Wave Reduced Neutron Widths of ^{192,194}Pt Resonances.” *Physical Review Letters*. DOI:10.1103/PhysRevLett.105.072502
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