



国立研究開発法人理化学研究所 仁科加速器科学研究センター  
第278回 RIBF核物理セミナー  
RIKEN Nishina Center for Accelerator Based Science  
The 278th RIBF Nuclear Physics Seminar

## The neutron lifetime with near-Exascale computing

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The fundamental particle theory called Quantum Chromodynamics (QCD) dictates everything about protons and neutrons, from their intrinsic properties to interactions that bind them into atomic nuclei. Quantities that cannot be fully resolved through experiments, such as the neutron lifetime (whose precise value is important for the existence of light-atomic elements that make the sun shine and life possible), may be understood through numerical solutions to QCD.

Measurements of the neutron lifetime and CKM matrix elements have evolved to become high-precisions tests of the existence of new physics.

Thanks to the Standard Model relation between the neutron lifetime, the axial coupling  $g_A$  of the neutron, and the CKM matrix element  $V_{ud}$ , we can use a QCD calculation of  $g_A$  and  $V_{ud}$  to learn about neutron decay from first-principles. Lattice QCD provides a robust framework to numerically compute inherently non-perturbative quantities from first principles. Starting only from the Lagrangian of QCD and owing to new improved numerical algorithms, we calculate the axial coupling of the neutron with unprecedented precision and thus obtain input about the neutron lifetime. This calculation is challenging and the outcome is very promising: it paves the way to understanding nuclear observables directly from QCD degrees of freedom with high accuracy. We directly solve QCD using Lattice Gauge Theory and calculate nuclear observables such as neutron lifetime. We have developed an improved algorithm that exponentially decreases the time-to-solution and applied it on the new CORAL supercomputers, Sierra and Summit. We use several optimization yielding 15% of peak performance when deployed across large fractions of CORAL.

This work was covered in the following press releases:

1. [http://www.riken.jp/pr/press/2018/20180531\\_1/](http://www.riken.jp/pr/press/2018/20180531_1/)
2. <https://www.bnl.gov/newsroom/news.php?a=112787>
3. <https://www.olcf.ornl.gov/2018/11/05/award-finalists-demonstrate-improved-qcd-code-for-supercomputing/>

\* The talk will be given in English language.

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<http://ribf.riken.jp/~seminar/>

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