Contribution ID: **2** Type: **Contributed Oral**

The KDK Experiment: A novel measurement of ^{40}K for rare-event searches and geochronology

Sunday, 19 February 2023 09:00 (15 minutes)

Potassium-40 (^{40}K) is a naturally-occurring, radioactive isotope impacting understanding of nuclear structure, geological ages spanning timescales as old as the Earth, and rare-event searches including those for dark matter and neutrinoless double-beta decay. The long-lived ^{40}K radionuclide undergoes electron capture decays to either the excited or ground state of its Ar daughter, of which the latter has previously not been measured, and estimates of its branching ratio are highly variable ($I_{\mathrm{EC}^0} \sim (0-0.8)\%$). In many dark matter searches, ^{40}K contamination produces a challenging 3~keV background from these electron capture decays in the expected direct-detection signal region, and the ill-known ground state contribution may affect interpretation of the DAMA/LIBRA dark-matter claim. In geochronology, the common omission of this decay branch impacts calculated ages. This rare third-forbidden unique decay additionally provides an estimate for the associated weak axial-vector coupling constant, the quenching of which affects calculated half-lives of neutrinoless double-beta decay. The KDK ("potassium decay") experiment has completed the first, successful measurement of this elusive ^{40}K branch using a coincidence technique between a high-resolution silicon drift detector to observe X-rays, and a high-efficiency ($\sim$ 98%) Modular Total Absorption Spectrometer (Oak Ridge National Labs) to tag gammas, ultimately differentiating ground and excited state electron capture decays of ^{40}K. With our measurement, the re-evaluated ^{40}K decay scheme yields $I_{\mathrm{EC}^0} = 0.098\% \overset{\mathrm{stat}}{\pm} 0.023\% \overset{\mathrm{syst}}{\pm} 0.010\%$. We report on the ^{40}K analysis, the extensive applications of our measurement, and a complementary result for zinc-65.

Supervisor

Philippe Di Stefano

Funding Agency

Queen's University

Supervisor Email

distefan@queensu.ca

Your Email

16lmh@queensu.ca

Primary author: HARIASZ, Lilianna (Queen's University)

Co-authors: FIJALKOWSKA, A (University of Warsaw); RASCO, BC (Oak Ridge National Laboratory); ROULEAU, C (Oak Ridge National Laboratory); STRACENER, DW (Oak Ridge National Laboratory); LUKOSI, ED (University of Tennessee); PETRICCA, F (Max-Planck Institute for Physics); DAVIS, H (University of Tennessee); YAVIN, I; CARTER, J (Berkeley Geochronology Center); KOSTENSALO, J (Natural Resources Institute Finland); NINKOVIC, J (MPG Semiconductor Laboratory); SUHONEN, J (University of Jyvaskyla); GOETZ, KC (Oak Ridge National Laboratory); RYKACZEWSKI, KP (Oak Ridge National Laboratory); MORGAN, LE (U.S. Geological Survey); MANCUSO, M (Max-Planck Institute for Physics); STUKEL, M (Queen's University); WOLINSKA-CICHOCKA, M (Oak Ridge National Laboratory); BREWER, NT (Oak Ridge National Laboratory); LECHNER, P (MPG Semiconductor Laboratory); DI STEFANO, PCF (Queen's University); RENNE, PR (Berkeley Geochronology Center); ICKERT, RB (Purdue University); GRZYWACZ, RK (Oak Ridge National Laboratory); LIU, Y (Oak Ridge National Laboratory); GAI, Z (Oak Ridge National Laboratory)

Presenter: HARIASZ, Lilianna (Queen's University)

Session Classification: February 19 Morning Session

Track Classification: Nuclear Physics