ANNOUNCEMENT: Interested Members of the University Community are Invited to attend the Final Oral Examination for the Degree of Doctor of Philosophy of

Paul Finlay

of the Department of Physics, on Friday, April 13, 2012 at 9:30 a.m. in Science Complex, Room 1511, University of Guelph.

Thesis Title: High-precision half-life and branching-ratio measurements for the superallowed $\beta^+$ emitter $^{26}\text{Al}_{m}$

ABSTRACT

By: Paul Finlay

Advisor: Dr. Carl Svensson

High-precision half-life and branching-ratio measurements for the superallowed beta+ emitter $^{26}\text{Al}_{m}$ were performed at the TRIUMF-ISAC radioactive ion beam facility located in Vancouver, Canada. The branching ratio measurement was performed with the 8pi Spectrometer, an array of 20 high-purity germanium detectors, in conjunction with SCEPTAR, a plastic scintillator array used to detect the emitted beta particles. An upper limit of $\leq 12$ ppm at 90% confidence level was found for the second forbidden beta$^+$ decay of $^{26}\text{Al}_{m}$ to the first 2$^+$ state at 1809 keV in $^{26}\text{Mg}$. An inclusive upper limit of $\leq 15$ ppm at 90% confidence level was found when considering all possible non-analogue beta$^+$/EC decay branches of $^{26}\text{Al}_{m}$, resulting in a superallowed branching ratio of 100.0000$^{+0.0015}_{-0.0015}$%.

The half-life measurement was performed using a 4pi continuous-flow gas proportional counter and fast tape transport system. The resulting value for the $^{26}\text{Al}_{m}$ half-life, $T_{1/2} = 6.34654(76)$s, is consistent with, but 2.5 times more precise than, the previous world average, and represents the single most precisely measured half-life of any superallowed emitting nucleus to date.

Combining these results with world-average Q-value measurements yields a superallowed beta-decay ft value of 3037.58(60)s, the most precisely determined ft value for any superallowed emitting nucleus to date. Combined with the small, and precisely quoted, theoretical isospin-symmetry-breaking corrections for this nucleus, the corrected Ft value for $^{26}\text{Al}_{m}$ of 3073.1(12)s is also the most precisely determined for any superallowed emitter by nearly a factor of two and now rivals the precision of all the other 12 precisely measured superallowed beta decays combined. The high-precision experimental ft value for $^{26}\text{Al}_{m}$ superallowed decay reported here provides a new benchmark to refine theoretical models of isospin-symmetry-breaking effects in superallowed Fermi beta decays.

Examination Committee: Dr. Rob Wickham Chair, Dr. Carl Svensson, Advisor Dr. Paul Garrett Dr. Ralf Gellert Dr. Oscar Naviliat-Cuncic (National Superconducting Cyclotron Laboratory, East Lansing, Michigan USA) External Examiner

CURRICULUM VITAE

EDUCATIONAL BACKGROUND:
M.Sc., Physics, University of Guelph, 2007.
B.Sc., Physics, University of Guelph, 2005.
ACADEMIC AWARDS:

INPC Young Scientist Award for best oral presentation (2010)
Brock Doctoral Scholarship (2007-2010)
NSERC Postgraduate Scholarship (2007-2008)
CPES Dean's Scholarship (2007-2009)
WNPPC 3rd prize, Best Graduate Student Presentation (2007)
Guelph University Graduate Scholarship (2006)
NSERC Canadian Graduate Scholarship (2005-2007)

PUBLICATIONS – Papers in Refereed Journals.

Precise half-life measurement of $^{19}$Ne
(In preparation)

High-precision branching-ratio measurement for the superallowed $\beta^+$ emitter $^{26}$Alm
(Submitted to Physical Review C)

Penning-Trap Mass Measurements of the Neutron-Rich $K$ and $Ca$ Isotopic Resurgence of the $N = 28$ Shell Strength
Physical Review C 85, 024317 (2012)

High-precision half-life measurement for the superallowed $\beta^+$ emitter $^{26}$Alm

High-precision branching ratio measurement for the superallowed $\beta^+$ emitter $^{62}$Ga
Physical Review C 78, 025502 (2008)

High-precision half-life determination for the superallowed $\beta^+$ emitter $^{62}$Ga
Physical Review C 77, 015501 (2008)