Parity Non-conservation in ^{180m}Hf; revisited

G. Goldring[1], S. Chamoli[1], T. Giles[2], M. Hass[1], U. Koester[2], M. Lindroos[2], I.S. Kraev[3], S. Lakshmi[1], B.S. Nara Singh[1], N. Severijns[3], J.R. Stone[4,5], N.J. Stone[4,6], F. Wauters[3], D. Zakoucky[7] and the NICOLE & ISOLDE Collaborations.

[1] *The Weizmann Institute of Science, Rehovot, Israel*
[2] *ISOLDE, CERN, CH-1211 Geneva 23, Switzerland*
[3] *K.U. Leuven, Instituut voor Kern- en Stralingsfysica, B-3001 Leuven, Belgium*
[4] *Department of Physics, University of Oxford, Oxford OX1 3PU, United Kingdom*
[5] *Department of Chemistry and Biochemistry, University of Maryland, College Park, Maryland 20742, USA*
[6] *Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennessee 37996, USA*
[7] *Nuclear Physics Institute, ASCR, 250 68 Rez, Czech Republic*

Measurements of Parity Non-Conservation (PNC) in bound nuclear states address the first order perturbation effects of the parity violating terms of the nuclear potential. With the exception of ^{180m}Hf[8^-], and possibly ^{19m}F[$1/2^-$], the few cases identified [1, 2] as promising have been shown to exhibit marginal or no effects. A recent measurement of the $\frac{17}{2}^-$ isomer in ^{93}Tc reduced the parity violating effect to a two standard deviation effect, too low to be considered significant [3].

The PNC effect in 5.5h ^{180m}Hf[8^-] has been studied in the 1970's by observing the forward-backward asymmetry with respect to the polarization axis of the 501 keV γ transition from a polarized radioactive source [4, 5, 6]. The same system was investigated by circular polarization with compatible results [6]. These measurements exhibited a large effect of ≈ 10 standard deviations, i.e. $1.66 \pm 0.18\%$. Since then ^{180m}Hf[8^-] has stood as the only bound nuclear state in which PNC is clearly observed.

Renewed interest in this positive result arises from its continuing uniqueness and the availability of improved experimental techniques for its measurement. In a new experiment a ^{180m}Hf beam developed at the ISOLDE, CERN, separator was implanted into a pure Fe foil cooled to milli Kelvin temperatures in the NICOLE on-line nuclear orientation facility. A magnetic field of 0.5 T was applied to polarize the continuously-generated ^{180m}Hf sample and temperatures were measured using a ^{57}Co orientation thermometer. The gamma decay was detected in HPGe detectors placed at 0°, 90° and 180° to the polarization axis. The direction of the magnetic field was reversed periodically, [thus reversing the sense of nuclear polarization.]

Data analysis is still in progress, but it is clear that: 1. the 501 keV $8^- \rightarrow 8^+$ transition exhibits a forward-backward $[0^\circ - 180^\circ]$ asymmetry of order 1% at temperatures between 60 mK and 7 mK, in agreement with earlier results and 2. that the band cascade transitions of 444, 332 and 215 keV exhibit zero asymmetry within errors (0.1%).

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