Test of time reversal invariance violation in the beta-decay of ^{56}Co

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Since the detection of *CP* violation in the neutral kaons,[1] there have been many attempts to detect the implied *T* violation in low energy phenomena. To date these searches have yielded no positive results, and for tests involving the beta-decay of the neutron the limits on *T* violation are quite small and are approaching limits of 10^{-4}.[2] Of course, without a good idea of the mechanism for *T* violation, present results do not rule out the existence of large effects in other systems.

The present work on ^{56}Co is motivated by the idea that *T* violation might appear through a mechamism that experiments involving allowed nuclear beta-decay are not sensitive to. One possibility is the existence of *T* violating second class currents. For the allowed decays of the neutron and ^{19}Ne, the dominant terms must be first class and hence any second class term would be kinematically surpressed.

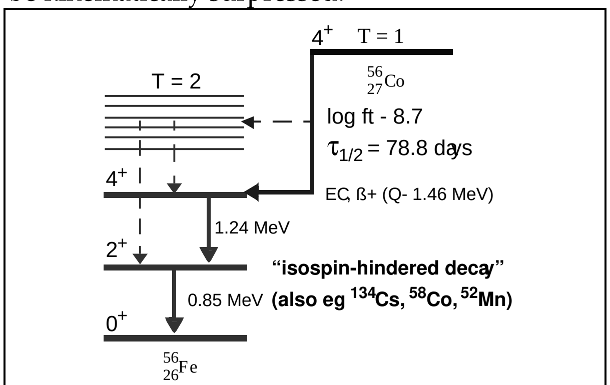

Fig. 1. The decay scheme of ^{56}Co.

In the decay of ^{56}Co this is not the case. Since it involves the decay between two different isospin multiplets (Fig. 1), the dominant terms need not necessarily be first class. The current limit on T violation in ^{56}Co is at the level of 10^{-2}. We intend to improve this by at least an order of magnitude. The relevant correlation for the detection of TRIV is of the form $E1(J\bullet k)(J\bullet p\times k)$, where *J* is the nuclear spin, *k* is the gamma-ray momentum and *p* is the beta-momentum. The required alignment will be achieved by low temperature nuclear orientation with an Oxford Kelvinox 400 that has been assembled and reaches temperatures of 5 mK. Unlike the previos effort,[3] this dilution refrigerator used is capable of maintaining a stable temperature for weeks in a single run. The gamma-rays from the excited state of ^{56}Fe are detected by conventional NaI(Tl) detectors. Besides stable refrigeration, the experiment has been improved by the development of a Si detector that operates at mK temperatures. This allows the detector to be placed very near the ^{56}Co source. Preliminary results for the *T* violating parameter are shown in Fig. 2. The result, $E1 = -0.001\pm0.005$, is consistent with no *T* violation.

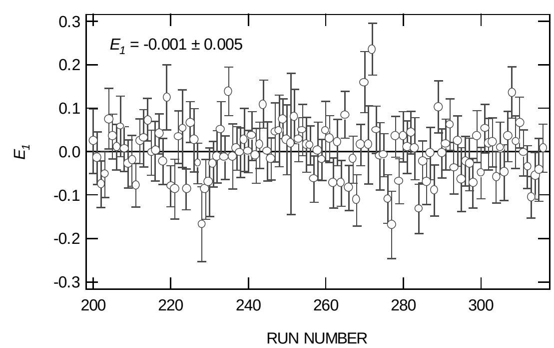

Fig. 2. Results for *E1* shown over several runs.

Footnotes and References

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