β−γ Directional Correlation in ^{22}Na

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We completed an experiment in 1997 using the Gammasphere to measure electroweak form factors in the β+ decay of ^{22}Na. It has been known for roughly 40 years that for ^{22}Na, the allowed approximation for β+ decay does not yield a good estimate of the log ft value, suggesting that higher order nuclear recoil corrections are significant. This situation offers an opportunity to test Standard Model predictions for these terms and to search for so-called second class currents.

We used the Gammasphere at the 88" Cyclotron to measure the angular correlation between the emitted β from ^{22}Na and the subsequent 1.274 MeV γ from the 2^+ excited state of the ^{22}Ne daughter nucleus. Gammasphere is an ideal instrument because of its segmentation, large solid angle coverage, and energy resolution. We performed the experiment in an off-line configuration, using a 6 μCi ^{22}Na source centered in the array. A plastic scintillator β detector was inserted in the array for 8% solid angle for the β's. Events when a Ge detector in Gammasphere detects a 1.274 MeV γ in coincidence with a detected β were recorded. We seek a correlation between the β and γ directions of the form $(1 + A\cos^2\theta)$ where θ is the angle between the β detector and the coincident Ge detector, and A is the directional correlation amplitude. We addressed the problem of varying Ge detector efficiencies by also counting events when only a γ is detected without a β. The ratio of coincident β-γ events to single γ counts is independent of detector efficiency, and this ratio as a function of θ yields the directional correlation A.

We took data at the 88" Cyclotron in January of 1996, January 1997, and June 1997. We acquired roughly 4×10^9 full-energy 1.274 MeV γ events on tape over 8 days of counting. We found $A = (5.3 \pm 2.4 \pm 0.5) \times 10^{-4}$, where the first error is statistical and the second systematic. The systematic error comes from uncertainty in the β and γ detector responses as a function of incident particle angle, and an estimate of background contribution to the angular anisotropy. Our uncertainty represents a factor of two improvement over past measurements.

Our measurment of A is one experimental datum from which one can determine the set of fundamental form factors in first forbidden order to this decay.[1] The precision of our measurement of A allows us to extract the induced tensor form factor $D = 25 \pm 7$, compared to a calculation of the first-class current contribution to D of 2.5 ± 0.5.[2] The disagreement could in principle be caused by a large second-class current contribution, but could also be due to an inaccurate determination of the width of the analog M1 tranistion in ^{22}Na, or an inaccurate shell model estimate of D. The M1 decay width can be measured using the 8π Array now at the 88" Cyclotron. More broadly, our experiment demonstrated the suitability of Gammasphere for β-γ correlation studies.

Footnotes and References

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2. M. Skalsey, *et al,* Phys. Rev. Lett. **49**, 708 (1985).

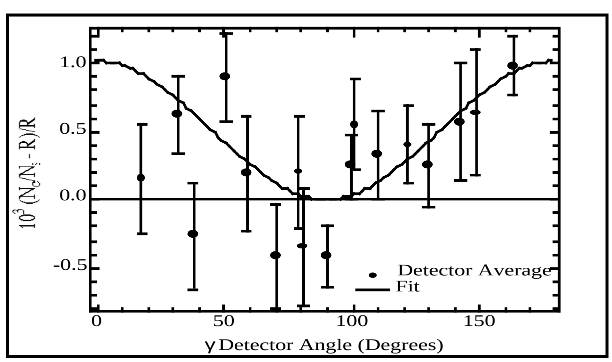

Fig. 1. β-γ coincidences as a function of Ge detector angle in Gammasphere