Transverse Beam Asymmetry Measurement During CREX

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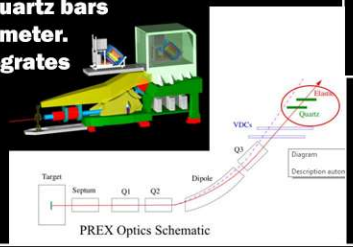
Introduction

Measuring the parity violating effects of the weak force experimentally using longitudinally polarized electrons requires a high degree of precision, and an emphasis on filtering out all potential interference. One possible source of interference comes from small portions of the polarization vector oriented transverse to the beam. One way to estimate the contribution from these transversely polarized electrons is to measure their effects when the transverse polarization is maximized. The scatering in this case is parity conserving, it comes from interference with the two photon exchange. The calcium radius experiment (CREX) at Jefferson Lab aimed to measure the weak charge distribution within calcium, and as part of constraining its uncertainty, measured the corresponding transverse asymmetry.

Experimental Design

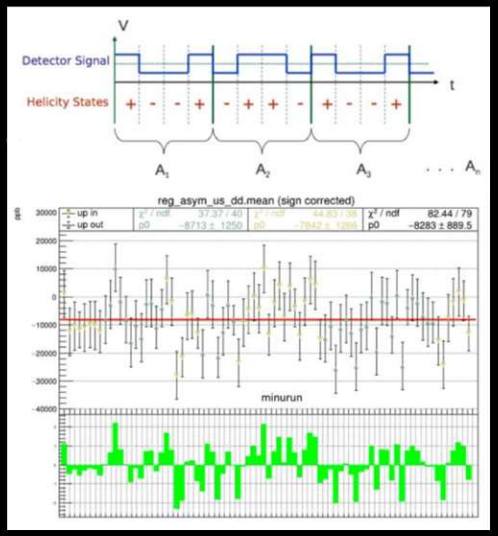
- PREX-II/CREX shared a detector package.
- Jefferson Lab polarized electron beam, 150 uA, 2.18 GeV, 0.03 Q^2
- Target ladder with ^{12}C, ^{40}Ca, ^{48}Ca, and ^{208}Pb targets.
- Hall A spectrometers with septum for small angle acceptance.
- Main detector quartz bars inside spectrometer.
- Experiment integrates electron flux over helicity correlated time windows.



PREX Optics Schematic

Data Aquisition

- Beam polarization is flipped rapidly. Each flip separates integration windows.
- Asymmetry is formed by taking the difference between opposite polarization states.
- By integrating over a long time scale, extreme statistical precison is achieved.
- For transverse vertical polarization, final asymmetry is the difference between right and left detector asymmetries.

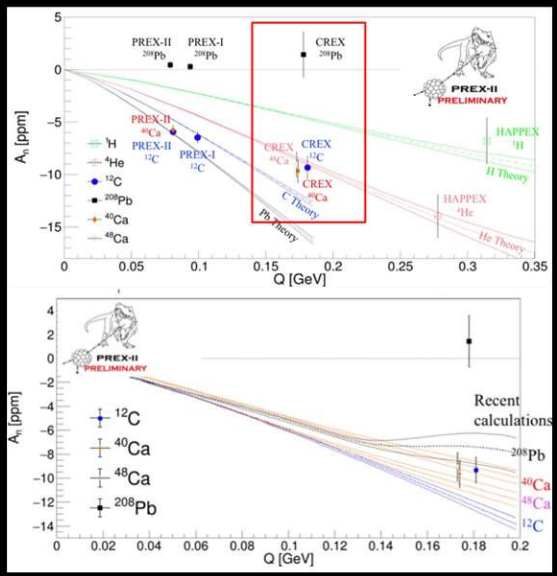


An example layout of helicity windows compared to an asymetry extracted from millions of such windows using CREX data.

Results

- Higher Q^2 lead point still consistent with zero, matching the unexpected PREX result.
- Calcium shows very little isotopic dependence, both points overlap and agree with models.
- Carbon is slightly below model prediction.

	Asymmetry (ppb)	Stat (ppb)
Carbon 12	-8167	880
Lead 208	-2765	1610
Calcium 40	-8405	926
Calcium 48	-7917	839



CREX transverse measurements compared to past experiments and theory models.

Conclusions

This transverse beam asymmetry measurement was sucesful in characterizing a source of uncertainty for CREX. It added addional experimental data points for medium weight nuclei that agree well with theory. However, even when compared to updated models, the reason for the small asymmetry in lead remain unexplained.