Measurement of parity violating γ-ray asymmetries of polarized neutron capture in ^{35}Cl and ^{139}La

Measurement of the Parity-Violating Gamma Asymmetry in the Capture of Polarized Cold Neutrons by Para-Hydrogen,

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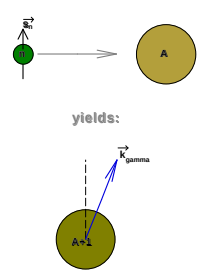
NPDG Testrun Goals

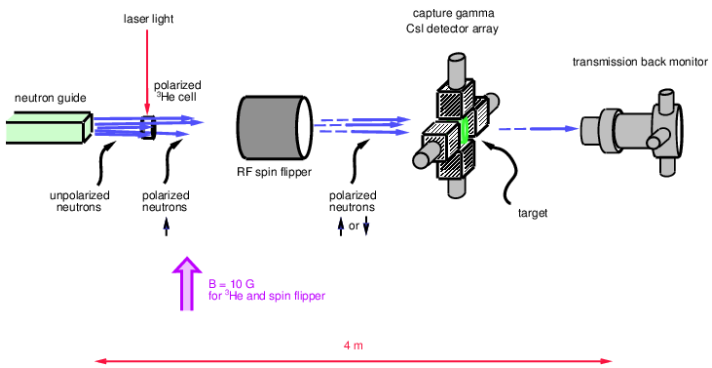
- Test the Apparatus for NPDG
- Make parity violating gamma-ray asymmetry measurements on the 10^{-6} level in three targets: ^{35}Cl, ^{139}La, and ^{113}Cd
- Search for a parity conserving gamma-ray asymmetry that could be used to align the NPDG detector array
- Verification of the procedure for identifying systematic and noise errors using LED data.

Differences between neutron capture on hydrogen and neutron capture on the heavier nuclei: ^{35}Cl, ^{139}La, and ^{113}Cd

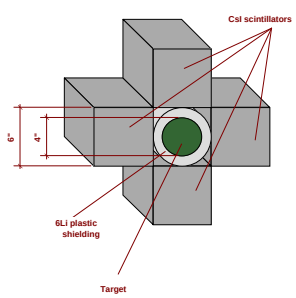
- ~1000 times larger PV asymmetry, ~ 10^{-5} vs 10^{-8}
- More than one gamma-ray per neutron capture
- Nuclear structure obscures the value of weak coupling constants



Experimental Setup



Definition of the Asymmetry Coefficient



Parity Violating Up/Down Case:

$$\Gamma = 1 + P A_\gamma \frac{\vec{s}_n \cdot k_\gamma}{|k_\gamma|}$$

Parity Conserving Left/Right Case:

$$\Gamma = 1 + P A_\gamma \frac{\vec{s}_n \cdot (k_\gamma \times k_n)}{|k_\gamma \times k_n|}$$

Either Case:

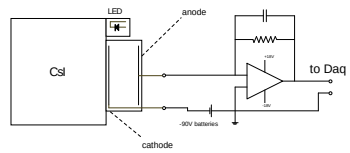
$$\Gamma = 1 + P A_\gamma \cos\theta$$

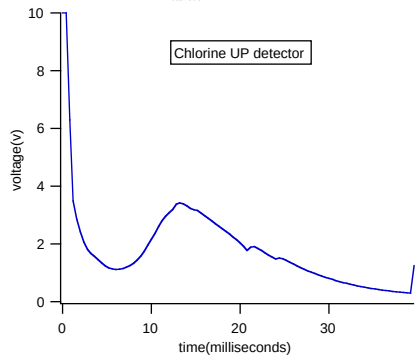
$$A_\gamma = \frac{\sqrt{\frac{U_\uparrow D_\downarrow}{U_\downarrow D_\uparrow}} - 1}{\sqrt{\frac{U_\uparrow D_\downarrow}{U_\downarrow D_\uparrow}} + 1}$$

Signals in Current Mode

- High statistics in a short time, there is no other way to get the 10^{18} events needed for NPDG

- No information on gamma-ray energies, it is lost as pulses overlap
- Spin dependent electronic noise creates a false asymmetry.

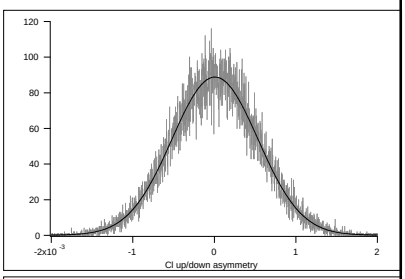


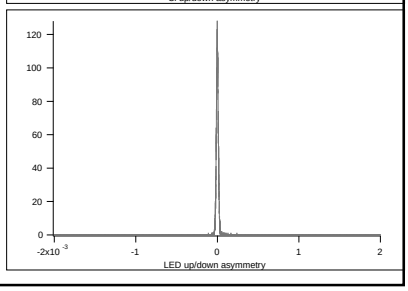


Raw Asymmetries

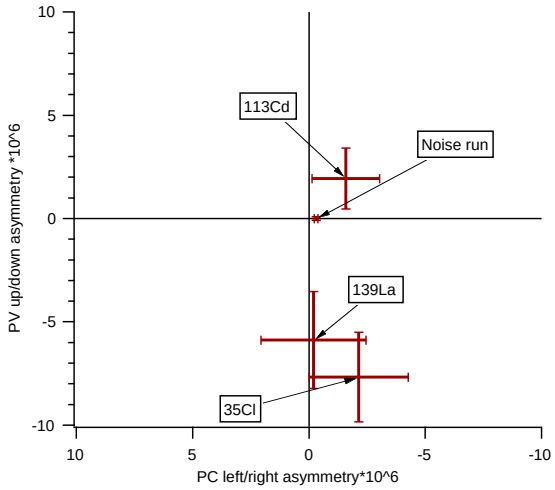
Raw Asymmetries $*10^6$

	PV $\vec{s}_n \cdot k_\gamma$	PC $\vec{s}_n \cdot (k_\gamma \times k_n)$
^{35}Cl	-7.68 ± 2.17	-2.14 ± 2.13
^{139}La	-5.88 ± 2.35	-0.20 ± 2.26
^{113}Cd	$+1.94 \pm 1.48$	-1.58 ± 1.45





Asymmetry Comparison



Extracting the Physics Asymmetries from the Raw Asymmetries

- Detector Offsets -> ~0.99
- Neutron Beam Polarization 40%-> ~2.50
- Spin Flipper Efficiency 96%-> ~1.02
- Solid Angle Weighted Cosine-> ~1.165

Results and Comparison with Past Experiments

PV $\vec{s}_n \cdot k_\gamma * 10^6$

	^{35}Cl	^{113}Cd	^{139}La
BPKLNP	-27.8 ± 4.9	-1.3 ± 1.4	-17.8 ± 2.2
ILL	-28 ± 5	-	-
Prelimary result	-23.1 ± 6.5	$+5.8 \pm 4.4$	-17.1 ± 6.8

PC $\vec{s}_n \cdot (k_\gamma \times k_n) * 10^6$

	^{35}Cl	^{113}Cd	^{139}La
Prelimary result	-6.4 ± 6.4	-4.7 ± 4.6	-0.6 ± 6.6

Implications for NPDG

- Tested the apparatus, the Spin flipper & Backmonitor are ready
- Measured to the 10^{-6} level in 8 hours with 1/12 of the detector array and 1/100 of the neutron flux
- Found systematic electronic noise on the 10^{-7} level, this must be improved by a factor of 1000
- Did not find a large parity conserving asymmetry with which to align the detector NPDG detector array