An update on the NPDGamma experiment

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Arizona State University
for the NPDGamma Collaboration

HAW14 Meeting of The American Physical Society
Introduction

NPDG radiative capture asymmetry

Apparatus

Measurements and error

Collaboration

Topics

- Brief overview of the $\bar{n}p \rightarrow d\gamma$ process
- Discussion of experimental apparatus and performance
- Measurements and sources of error
- Discussion of previous hadronic weak interaction results with preliminary error bars for NPDGamma

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An update on the NPDGamma experiment
Radiative \( n - p \) capture - PV in the \( \Delta I = 1 \) channel

- Figure shows electric and magnetic dipole transitions
- The \textbf{hadronic weak interaction} produces an admixture of irregular states into states with opposite parity.
- In cold neutron capture, parity violation arises from a P-wave admixture into the \( ^3S_1 \) ground state.
- The \( \vec{n}p \rightarrow d\gamma \) asymmetry, \( A_\gamma \), is sensitive to interference between \( \Delta I = 1 \) transitions (\( \pi \), neutral current).

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An update on the NPDGamma experiment
The $\bar{n}p \rightarrow d\gamma$ asymmetry ($A_\gamma$) in the DDH model

$A_\gamma, PV \approx -0.107h_\pi^{1} - 0.001h_\rho^{1} - 0.004h_\omega^{1}$

$\frac{d\omega}{d\Omega} \propto 1 + A_\gamma, PV \hat{k}_\gamma \cdot \hat{\sigma}_n + A_\gamma, PC \hat{k}_\gamma \cdot (\hat{\sigma}_n \times \hat{k}_n)$
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- Polarization and spin-flip efficiency are 95\,(1\,\%) and 98\,(1\,\%) respectively.

- RF spin rotator flips spins in an 8-pulse sequence designed to cancel up to 2nd order gain fluctuations.

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16-liter LH₂ target surrounded by 3π CsI (Tl) 48-scintillator array

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An update on the NPDGamma experiment
Supplemental measurements

35Cl - Test of sensitivity/multiplicative systematics

![Graph showing asymmetry](image)

\[
\chi^2 / \text{ndf} = 28 / 22
\]

Prob = 0.1758

Chlorine measurement consistent with previous results

Beam off asymmetry - Test of additive instrumental systematics

Aluminum alloy 6061 - Significant background signal
Supplemental measurements

$^{35}$Cl - Test of sensitivity/multiplicative systematics

Beam off asymmetry - Test of additive instrumental systematics

Zero instrumental asymmetry at less than $10^{-9}$

Aluminum alloy 6061 - Significant background signal

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$^{35}$Cl - Test of sensitivity/multiplicative systematics

Beam off asymmetry - Test of additive instrumental systematics

Aluminum alloy 6061 - Significant background signal

Neutron capture in aluminum makes up $\sim 20\%$ of total gamma signal with LH2 target
LH2 measurements

- 250 beam days of data with LH2 target
  - 850 - 1350 kW beam power (SNS at ORNL reached full potential in at the end of 2013, and continued strong in 2014)
- 60 beam days of background asymmetry data
- Preliminary result of $A_\gamma (\vec{n}p \to d\gamma)$
  - Official statement from Collaboration regarding $A_\gamma$: “The preliminary result for the parity-violating asymmetry $A_\gamma$ is that it is small with a statistical error of about 13 ppb”
  - Corresponds to a constraint on $h_\pi^1$ on the natural scale of $10^{-7}$ for an unambiguous test of the DDH best value
  - Statistical errors dominate uncertainty
- Final result in the works
LH2 Raw Asymmetries

$\times 10^{-6}$

- $\cdot$ ASU analysis
- $\square$ UT analysis
- $\triangle$ IU analysis

Detector Pair

Raw Asymmetry

ASU analysis
UT analysis
IU analysis

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An update on the NPDGamma experiment
Weak couplings

Previous constraints (Haxton and Holstein 2013)
Weak couplings

Preliminary statistical uncertainty (not a result)

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