Compton Scattering
from a High Pressure Polarized $^3$He Target at HI$\gamma$S

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Abstract

The High Intensity Gamma Source (HI$\gamma$S) at Duke Free Electron Laboratory opens a new window to the study of fundamental quantities related to the structure of the nucleon through double polarized Compton scattering from a polarized nuclear target. We propose first measurements of the spin-dependent asymmetries from elastic Compton scattering of circularly polarized photons from a high-pressure polarized $^3$He gas target. The Compton scattered photons will be detected by the HI$\gamma$S NaI Detector Array (HINDA) system. In combination with the forward and backward polarizabilities extracted from existing experiments, the proposed experiment will allow for the first time the extraction of neutron individual spin polarizabilities, and provide crucial tests of predictions based on effective field theories, dispersion theories, and lattice QCD calculations. The proposed experiment will be carried out at a photon energy of 125 MeV at HI$\gamma$S. We request a total beam time of 1260 hours with 100% efficiency photon beam at a minimum photon flux of $5 \times 10^7$/sec for a photon energy spread of 5.0%. In addition, we request a beam test for 60 hours at an incident photon energy of 90 MeV with an energy spread of 3% and a minimum photon flux of $3 \times 10^7$/s for detector and background studies for the proposed experiment.