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A HIGH ENERGY PHOTON POLARIMETER FOR ASTROPHYSICS

Abstract

Photon polarimetry for energy below a few MeV is a very active field of astrophysical research, and some examples of the productive use of polarimetry at these energies include: detection of exoplanets, analysis of chemical composition of planetary atmosphere, and investigation of interstellar matter, quasar jets and solar flares. However, no polarization measurements are available in the medium and high energy regions because of the instrumental challenges.

During the last decade, observations from the AGILE and FERMI-LAT pair production telescopes have enhanced our understanding of gamma (γ) ray astronomy. With the help of these telescopes numerous high energy γ ray sources have been observed. However, the current measurements are insufficient to fully understand the physics mechanism of such γ ray sources as gamma ray bursts, active galactic nuclei, blazars, pulsars, and supernova remnants. Even though both telescopes cover a wide range of energy (from 20 MeV to more than 300 GeV), neither of them is capable of polarization measurements.

Medium to high energy photon polarimeters for astrophysics were proposed by the NASA Goddard and the Saclay group. Both are considering $Ar(Xe)$ based gas-filled detectors: the Time Projection Chamber with a micro-well or micromega section for amplification of ionization. Presented will be evaluation of the features of an electron-positron pair polarimeter for the full energy range from 20 MeV to 1000 MeV and proposed a specic design for a polarimeter in the 100 to 300 MeV energy range using silicon micro-strip detectors, MSDs, whose principal advantage with respect to the gas-based TPC is that the spatial and two-track resolution is about five to ten times better. The proposed concept uses a stack of silicon MSD where they play the roles of both a converter and a tracker. Study supported by a Monte Carlo simulation shows that with a one-year observation period the polarimeter will provide 5.5% accuracy of the polarization degree for a photon energy of 100 MeV, which would be a significant advance relative to the currently explored energy range of a few MeV. The proposed polarimeter design could easily be adjusted to the specific photon energy range to maximize efficiency if needed.

The polarimeter designed by NCCU-NASA-URC faculty and the leading scientist in this field from New Hampshire University, NASA Goddard, JLAB, and University of Rome when implemented will have an enormous impact on astrophysics. More information about the project may be found in recent article available at: http://arxiv.org/pdf/1501.05592v1.pdf