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POLARIMETER FOR HIGH-ENERGY GAMMA-RAY ASTROPHYSICS

Abstract

Photon polarimetry is important for understanding the nature of the emission mechanisms responsible for blazars, GRBs, X-ray binaries, pulsars, and magnetars as demonstrated by recent space exploration missions devoted to gamma-ray astronomy, AGILE, FERMI-LAT, and EGRET, and recent theoretical and experimental publications. However, no polarization measurements are available in the medium and high-energy regions because of the instrumental challenges.

A high-energy photon polarimeter for astrophysics studies in the energy range from 10 MeV to 2 GeV is considered. It is based on pair production and Si microstrip detectors and a prototype that was already developed and tested (40 MeV in Duke, 300 MeV in Brookhaven, and 2.4 GeV in the Osaka-Spring-8 laboratory) and sucessfully used as part of a Jlab 6 GeV experiment. It acheived the highest analyzing power recorded at energies above 50 MeV [1]. The proposed concept for the space polarimetry based on that prototype uses a stack of silicon microstrip detectors where they play the roles of both a converter and a tracker. The purpose of this presentation is to outline the parameters of such a polarimeter and to estimate the productivity of measurements.

The prototype is based on our original design [2], experiments, and Monte Carlo simulations used to optimize the polarimeter for 30 layers of cells. It will provide 11-15% photon efficiency and 1 mrad angular resolution. In a yearlong observation, the polarization of the photons from the Crab pulsar will be measured to 5.5% accuracy at an energy cut of 100 MeV and 15% accuracy at an energy cut of 1,000 MeV, which would be a signicant advance relative to the currently explored energy range of a few MeV. The proposed polarimeter design could easily be adjusted to the specic photon energy range to maximize efficiency if needed.

[1] A Polarimeter for Linearly Polarized High Energy Photons, B. Wojtsekhowski, D Tedeschi, and B. Vlahovic, Nuclear Instruments and Methods, 515 (3), (2003) 605-613.

[2] Maxim Eingorn, Lakma Fernando, Branislav Vlahovic, Cosmin Ilie, Bogdan Wojtsekhowski, Guido Maria Urciuoli, Fulvio De Persio, Franco Meddi, and Vladimir Nelyubing, A high energy photon polarimeter for astrophysics, Journal of Astronomical Telescopes, Instruments, and Systems 4 (1), 011006 (2018).