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EPSI R&D: Developing an Innovative Electron-Positron Discrimination Technique for Space Applications

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The direct detection of antimatter in cosmic rays is essential for understanding the mechanisms behind their acceleration and propagation, and serves as a powerful tool in the indirect search for dark matter. Traditionally, charge sign discrimination rely on magnetic spectrometers. However, these instruments are not ideal for extending measurements to higher energies in a short time frame. As current and upcoming space experiments targeting the high-energy domain are primarily based on large-scale calorimeters, there is a strong need for an alternative method of charge sign discrimination compatible with such systems.

This is the primary objective of the Electron Positron Space Instrument (EPSI) project - a two year R&D initiative funded in Italy through the PRIN (Projects of Relevant National Interest) program. The project aims to revive a concept proposed long time ago: using synchrotron radiation emitted by charged particles traversing Earth's geomagnetic field. By simultaneously detecting the lepton with an electromagnetic calorimeter and its associated synchrotron photons with an X-ray detector, it is possible to distinguish between electrons and positrons on an event-by-event basis. The central challenge lies in developing an X-ray detection array that features a large active area, high detection efficiency, a low energy threshold, and compatibility with space constraints.

In this presentation, we explore the feasibility of implementing this technique in future space missions. We outline a preliminary instrument design and discuss the difficulties posed by astrophysical background. Furthermore, we introduce the proposed X-ray detector concept, which involves a detection cell composed of a small scintillator, coupled to a large-area SiPM, wrapped with enhanced specular reflector apart from a thin aluminum layer used as entrance window. Various configurations of these components and geometries are currently undergoing testing through laboratory experiments and comprehensive simulations.

We will report on the current status of the EPSI R&D project and outline the next steps toward achieving its objectives.

Secondary track

T01 - Astroparticles, Gravitation and Cosmology

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