【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Mathematical and physical sciences)

Title of Project : Search for dark matter and cosmic-ray nearby -sources by observing high energy electrons and positrons

Shoji Torii
(Waseda University, Faculty of Science and Engineering, Professor)

Research Area : Particle/Nuclear/Cosmic ray/Astrophysics

Keyword : Cosmic ray (experiment)

【Purpose and Background of the Research】

One of the most important unsolved problems in the Universe is a unidentifiable dark matter which is understood to contribute the 23 % of energy density in contrast to the 4% of baryonic matters. The most possible candidate of dark matter is "Weakly Interacting Massive Particles (WIMPs)". The WIMPs are very possible to be the particles which were produced at the first stage of the Universe. The identification of WIMPs is, therefore, the most important issue, and very many experiments for searching dark matter have been carrying out.

Electrons and positron (we hereafter refer to electrons) generated by annihilation of WIMPs could bring a prominent feature in the observed energy spectrum, which could easily be distinguished from the power law spectrum caused by the common astrophysical acceleration process. Then, the observation should be a powerful method to detect WIMPs as well as the observation of anti-protons and diffuse gamma-rays. We are aiming to search WIMPs by observing the electrons up to the TeV region with a balloon-borne detector and a space experiment on ISS. The spectral feature expected by cosmic ray nearby sources is similar with that by dark matter. However, it is promising to distinguish the sources from dark matter by detecting an anisotropy of the arrival directions of the electrons .

【Research Methods】

We will carry out a search of dark matter with a balloon-borne instrument (bCALET), which has being developed as a proto-type of the detector,CALET: Calorimetric Electron Telescope, which will be onboard ISS. The first balloon payload, bCALET-1, was successfully flown to observe the electrons in 1-10 GeV. We will carry out the next flight with an improved detector, bCALET-2, in FY 2009 and will confirm the capability of the detector at energies of 1-100 GeV. As a final goal, we will achieve a 50-days observation with the bCALET-3 presented in Fig.1, by long duration ballooning in the southern hemisphere and/or in the Arctic.

【Expected Research Achievements and Scientific Significance】

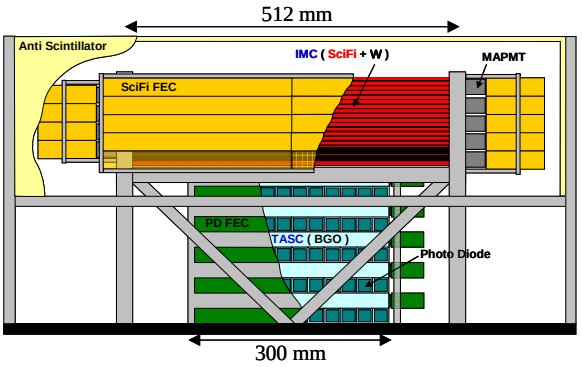

Fig. 1: Schematic side view of bCALET-3. The upper part is an imaging calorimeter (IMC) consisted of scintillating fibers and tungsten plates. The lower part is a total absorption calorimeter (TASC) of BGO logs. Anti-coincidence detector covers the whole structure.

We expect to observe about 3,800 events of the electrons over 100 GeV from the observation with bCALET-3, and to accurately verify the possible excess of the electron flux by WIMPs at energies of 300-800GeV, observed by previous experiments. The existence of a nearby source as Vela could be tested with a confidence level of 99 % at the TeV region.

【Publications Relevant to the Project】

・Cosmic Ray Electron Spectrum above 100 GeV from PPB-BETS Experiment in Antarctica: K.Yoshida, S.Torii, T.Tamura, Y.Katayose, J.Nishimura et al., Advances in Space Research, 42 (2008) pp. 1670-1675.

・The Energy Spectrum of Cosmic-Ray Electrons from 10 to 100 GeV Observed with a Highly Granulated Imaging Calorimeter : S.Torii, T.Tamura, K.Yoshida, J.Nishimura, et al., Astrophysical Journal, 559 (2001) pp.973-984.

【Term of Project】 FY2009-2013

【Budget Allocation】 161 , 400 Thousand Yen

【 Homepage Address and Other Contact Information】

http:// www.crlab.rise.waseda.ac.jp/
torii.shoji@waseda.jp