The energetic electron measurement during the flight of the sounding rocket S-310-35 using avalanche photodiodes

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An Auroral Particle Detector was installed on the sounding rocket S-310-35 and launched on December 13th, 2004. The measurement have been performed at the altitude of 90-140km, plunging into aurorae. During a flight of the rocket, energy and pitch angle distributions of auroral electrons over 3 to 15 keV have been measured with this novel instrument using Avalanche Photodiodes (APD). APD is a promising device for counting electrons individually with the information on the energy. Incident electrons are collimated and the energy of each electron is dispersed by a homogenous magnetic field. On the bottom, four APDs are installed from the lowest energy side to the higher, and each of APD has 11 energy channels. The time resolution is 10msec. In synchronization with the rocket spin, 1 sec was needed to obtain a distribution function covering all pitch angles.

In the sensor part, photon rejection system and four avalanche photodiodes were installed. In order to reject incoming photons, trajectories of incident electrons were deflected with a homogenous magnetic field supplied by a permanent magnet. Since electron trajectories are different depending on their energies, four avalanche photodiodes are necessary to cover the entire energy range. This system worked well and only two channels of the four have detected auroral electrons because the energy of ambient electrons were very low during the flight. The effect of the photon to the noise was quite small as was intended. All of the electrical system of the detector were worked well. This instrument detected gyrotropic electrons synchronizing with the half cycle of the rocket spin.

Although APDs are usually applied for photoelectronic devices, application of avalanche photodiodes in space for low energy electron detection is a novel technique. Comparing with conventional SSDs, which are widely used for high-energy electron measurements, utilization of avalanche photodiodes can drastically improve energy resolution and the lowest limit of detectable energy of impinging electrons. The avalanche photodiode is a kind of p-n junction semiconductor that has an internal gain due to the avalanche amplification of electrons and holes in the strong electric field within its depletion region.