将来オーロラ観測ロケットならびに小型衛星搭載可視・紫外イメージャーの開発

坂野井 健 [1]; 三好 由純 [2]; 浅村 和史 [3]; 細川 敬祐 [4]; 平原 聖文 [5]; 斎藤 義文 [6]
[1] 東北大・理; [2] 名大 ISEE; [3] 宇宙研; [4] 電通大; [5] 名大・宇地研; [6] 宇宙研

Development of auroral visible and ultra-violet imagers for future sounding rocket and small satellite missions

Takeshi Sakanoi[1]; Yoshizumi Miyoshi[2]; Kazushi Asamura[3]; Keisuke Hosokawa[4]; Masafumi Hirahara[5]; Yoshifumi Saito[6]
[1] Grad. School of Science, Tohoku Univ.; [2] ISEE, Nagoya Univ.; [3] ISAS/JAXA; [4] UEC; [5] ISEE, Nagoya Univ.; [6] ISAS

http://pparc.gp.tohoku.ac.jp/

We report feasible design of compact-sized optical system for imaging and spectrometer in future space and rocket missions. In particular, we focus on the auroral rocket project G-CHASER which will be launched from Andoya, Norway in January 2019. Recent progress in imaging and spectroscopy in the ultra-violet and visible ranges enable us to study detailed mechanisms of auroral acceleration process as well as wave-particle interaction in geospace. We are now discussing possibilities of next-generation satellites which will measure auroral and thermospheric phenomena, and also plan to carry out rocket experiments for pulsating aurora (PsA). In this presentation, we will give scientific issues to be solved in the auroral and thermospheric studies, and the most recent status of space-based missions.

We propose a visible auroral camera for G-CHASER rocket in addition to medium and high-energy particle detectors. In this rocket mission, we particularly concern on PsA phenomena to understand the loss of the Earth's radiation belts due to precipitation of high-energy magnetospheric electrons through the wave-particle interaction. We will observe the optical thickness of pulsating aurora and the time-dispersed curve in electron energy spectra using the high-time resolution simultaneous optical and particle data. The data is useful to imply the impact of high-energy electrons on the Earth's atmosphere, in particular, the possible change of ion chemistry including ozone (O3) due to precipitation of MeV electrons during PsA. We have started designing of auroral imaging camera (AIC) for this rocket mission. AIC mainly consists of optical objective lens, CCD and electronics. We use a commercial-based fast lens with a wide field-of-view (FOV) of 90 (azimuthal) x 180 (vertical) deg. We adopt a Watec WAT-910HX as a CCD detector. This is a half inch (6.45 x 4.84 cm) CCD with pixels of 768 x 494, and the binning of 384 x 30 pixels is made by the electronics to have a 2 x 16 bin image. The electronics also provide appropriate power supplies for the CCD, FPGA to control the CCD exposure timing, and data production for common electronics of the rocket system that is transferred to the ground. The candidate of target auroral emission is the O2 A-band at 762 nm, and/or N2 emission. We will complete the detailed design within this year and fabricate in early 2018.

In addition we are now discussing on the possibilities for future small- and micro-scale satellites to understand the small-scale aurora and the coupling system between magnetosphere and ionosphere. We carried out the conceptual design of auroral camera assuming that the satellite is three axis stabilized and its apogee is 3000 km. For the visible imager, the target is auroral N2 1P emission at 670 nm and/or O2 A-band emission. The focal lens of objective lens is 100mm with Fno of 1.5, and the preferred detector is 1k x 1k EMCCD with pixels of 1024 x 1024 of which each pixel size is 13 x 13 um. Then, the FOV is 7.6 x 7.6 deg, which enable us to cover 400 x 400 km and 200 x 200 km with spatial resolution of 2 km/bin and 1km/bin (assuming 5-pix binning) viewed from altitudes of 3000 km and 1500 km, respectively. For the ultra-violet imager, we discussed the feasible FOV size viewed from 3000 km altitudes, and considered that the FOV in the range from 34 x 34 deg (1800 x 1800 km at the ionosphere) to 51 x 51 deg (2700 x 2700 km at the ionosphere) is preferable. We designed the wide and fast objective system by using Aplanat mirrors (FOV=40 x 48 deg, Fno=2.4). The candidate of target auroral emission is the N2 LBH band at 140-160 nm. We also concern the feasibility of 2D detector among CCD, CMOS and IICMOS, mirror coating to improve reflectivity and filter to block the H-Ly alpha of geocoronal emission at 122 nm.