FACTORS搭載可視・紫外カメラならびにオーロラロケットLAMP可視カメラによる微細-広域オーロラダイナミクス

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Auroral dynamics revealed by new visible and ultraviolet imagers for a future satellite FACTORS and sounding rocket LAMP

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We report science subjects, instrumental design, development plan and identification of issues of the visible and ultraviolet imagers for a future satellite project called FACTORS that aims to understand the coupling processes in the terrestrial magnetosphere/ionosphere/thermosphere and the acceleration and transportation of the space plasma and neutral atmospheric particles. FACTORS stands for Frontiers of Formation, Acceleration, Coupling, and Transport Mechanisms Observed by Outer Space Research System that is proposed as a multi-satellite formation flight mission. This will be a community exploration mission in Japanese space research, and the working group was approved by ISAS/JAXA. In this presentation, we mainly focus on visible and ultraviolet remote imaging of auroral and airglow emissions. A visible imager (VISAI) on FACTORS will measure small-scale auroral structures at a wavelength of auroral prompt emission at N2 1st PG with high-time (~0.1s) and high-spatial (~1 km) resolutions using a science CMOS or EMCCD. The FOV of 8 x 8 deg.^2 covers a 400 x 400 km^2 area viewed from 3000 km altitude. Combined with particle and electric/magnetic field data by FACTORS, we will reveal the time and spatial variations of acceleration/scattering process in the complicated magnetosphere-ionosphere coupling system, and the high-spatial and high-time resolution imaging is essential to understand small-scale variations of Alfven aurora, pulsating aurora, etc. Currently, we design a wide (~40 x 40 deg.^2) FOV far-ultraviolet imager (FUVI) which covers ~2500 x 2500 km^2 area viewed from 3000 km altitude. We plan to adopt a filter wheel in FUV imager to change the wavelengths between O 135.6 nm and the N2 LBH band at 140-160 nm. Wide-field multi-wavelength FUV images enable us to examine large-scale auroral dynamics like westward-travelling surge during substorms, omega-bands, and provide us to understand the global thermospheric activity from the O/N2 airglow ratio. We examined precise orbit analysis for FACTORS, considering rocket launch conditions, inclination, locations of apogee and perigee, and feasibility of simultaneous image-particle measurement in the winter hemisphere. We also plan to perform specific studies for CMOS/EMCCD detectors suited for this mission, and carry out radiation tests of detectors.

Related to FACTORS, we are now carrying out the ongoing sounding rocket project LAMP which is scheduled to be launched at Poker Flat research range in winter of 2020 to clarify microburst; short-term relativistic electron precipitation probably associated with pulsating aurora. We are developing two CMOS cameras called AIC2 installed on a despun platform of the LAMP rocket to derotate rocket spin. One camera AIC2-S1 measures N2 1st PG emission with a narrow-FOV and fast lens (F-number=0.95, f=17 mm, FOV=28 x 28 deg.^2), and another camera AIC-S2 measures OI 844.6nm emission with a wide-FOV (F-number=1.6, f=3.5 mm, FOV=106 x 106 deg.^2). Both cameras used the ZWO ASI-180MM CMOS detector. AIC2-S1 will take fine structure of pulsating aurora in the region more than 100 x 100 km^2 around the magnetic footprint with a few kilo-meter resolution, while AIC2-S2 will cover from the magnetic footprint to the limb slantly looking westward from the rocket to avoid dawn light contamination and obtain an altitude distribution of pulsating aurora in the both of E- and F-regions. Both cameras have a high frame rate with 10Hz sampling. The imaging data combined with precipitating electron data in the wide energy range enable us to investigate the relativistic electron precipitation microbursts that is probably caused by chorus waves in the magnetosphere, and relationship to pulsating auroral emission.