Spectral investigations of near infrared aurora and airglow at 1.0-1.6 microns: 1-year ground-based imaging spectroscopic observation at Syowa station (69.0˚S, 39.6˚E)

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The motivation of this study is further understanding of dayside magnetosphere and terrestrial atmosphere coupling system by using continuous observation. Dayside aurora, polar patch, and airglow should be key phenomena for the understanding. In particular, those phenomena in near infrared (NIR) wavelength are crucially important because lower background sky luminosity by Rayleigh scattering may allow us to conduct ground-based optical observation even in dayside. Continuous dayside optical monitoring with high temporal and spatial resolutions in aurora region and cusp give us a clue to understanding of substorm pre-onset sequences at cusp region, magnetopause dynamics related to solar wind shocks, and wave-particle interactions due to electromagnetic ion cyclotron waves and whistler mode chorus. However, NIR aurora has a total lack of its spectral information with enough resolution to make a feasibility study in comparison to that in visible wavelength.

We designed a narrow field spectrometer with medium-high spectral resolution that mainly consists of Czerny-Turner type imaging spectrometer (HORIBA, iHR320) with one entry port and two exit ports. This spectrometer has two mirrors and three diffractive gratings in a rotating turret. A toroidal mirror for collimating corrects for astigmatism so that the tangential (resolution optimized) and sagittal (imaging optimized) focal planes cross at the center of the focal plane. Another larger focus mirror allows the entire flat field to be used without vignetting. Collecting optics, equipped outside the spectrometer, are a gold coated off-axis parabolic mirror and a NIR longpass filter for removal of secondary diffracted light in visible wavelength. Using 1-d InGaAs array (1024 pixels) and 600 gr/mm grating, spectral range and spectral range per pixel are 119 nm and 0.11 nm/pixel, respectively.

We started ground-based spectroscopic observation in NIR wavelength ranging from 1.0 to 1.6 microns, which covers strong OH airglow emissions and auroral emissions in $N_2$1st Positive (1.2 microns) and N_2^+ Meinel (1.1 and 1.5 microns) [Jones 1974; Zhou et al., 2007], at Syowa Station (69.0˚S, 39.6˚E) in Antarctica from March 2018. OH airglow spectrum in NIR can be well resolved even in water vapor absorption region. OH rotational temperature is successfully estimated using OH 3-1 band P1(2) and P1(4) emissions. However, auroral emissions were not clearly identified at 1.52 micron (N2+ Meinel) so far. Further investigations are needed including 1.10 micron (N2+ Meinel) and 1.24 micron (N2 1P). In this presentation, we are going to report results in more detail based on one year observation.

Keywords: Near Infrared, Spectral observation, Aurora, Airglow, Mesopause, Antarctica

