Aurora and airglow observations by an optical spectrograph at Tromsø, Norway

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We have been operating an optical spectrograph for aurora and airglow observations at Tromsø, Norway (69.6ºN, 19.2ºE) since October 2016. The aperture of the spectrograph, i.e. F-number, is 4. The field-of-view (FOV) is 0.03ºx2º, which is pointed at the local magnetic field-aligned direction. As an advantage, this spectrograph is capable to change its resolution and range in the observation wavelength by switching between multiple diffraction gratings.

One of research targets is the pulsating aurora (PsA). The PsA is a diffuse-type aurora, which is characterized by a repetition of brighter (ON) and darker (OFF) auroral emissions with periods of a few to a few tens of seconds. For PsA observation, the spectrograph is mainly tuned for visible range from 480 to 880 nm with a resolution of 1.6 nm and an interval of 0.4 nm. The time resolution is 1 second, and thus it can observe PsAs, which have periods of a few seconds or longer. We performed the data analysis of multiple PsA events, and revealed the PsA spectra for the first time. As the results, the OI 630.0-nm emissions and the N_2 1PG emissions were found in the both spectra during ON and OFF in the PsA events. The spectra of pulsations were derived as difference spectra between the ON and OFF spectra. From the obtained spectra of pulsations, it is found that dominant pulsations at 630.0 nm were coming from the N_2 1PG (10,7) band, and there were less or minor contributions of the OI 630.0 nm to pulsations at 630.0 nm.

Another target is the sodium (Na) nightglow from Na D_1 (589.756 nm) and D_2 (589.158 nm) transitions, which are chemically produced emissions in the sodium layer in the mesosphere and lower thermosphere (MLT). The chemical process in the Na D_1 and D_2 emissions have been explaned by the Chapman mechanism for many years. The Chapman mechanism expects that the ratio between Na D_1 and D_2 emissions should be constant. On the other hand, some recent observations indicate the D_1/D_2 ratio can be variable, and propose a modification to the Chapman mechanism. To contribute this issue, we have been making spectral observations in the Na D_1 and D_2 lines. By switching to the 4x higher resolution diffraction grating in the spectrograph, the observation wavelength can be tuned for 540-640 nm with 0.4-nm resolution and 0.1-nm interval. Such high wavelength resolution enables that the Na D_1 and D_2 lines can be measured seperately.

In the presentation, we will introduce some recent results obtained from such spectral observations in aurora and airglow above Tromsø.

Keywords: Optical spectrograph, Aurora, Airglow, Tromsø

