Spatial distribution of multiple temporal variations of pulsating aurora

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Pulsating aurora (PsA) is a kind of diffuse aurora which almost always appears in the morning side during the recovery phase of auroral substorm. PsA typically has two distinct temporal variations. One is so-called main pulsation whose period ranges from a few to a few tens of seconds. The other is a few Hz modulation (internal modulation), which is occasionally seen during the ON phase of the main pulsation. Previous studies have suggested that the temporal variation of PsA is characterized by wave-particle interaction between whistler-mode chorus waves and high energy electrons in the magnetosphere. Especially, it has been indicated that there is one to one correspondence between the amplitude variation of chorus waves and the luminosity modulation of PsA. However, there have been no studies which analyzed the spatial distribution of multi-scale temporal variations of PsA(i.e. the main pulsation and internal modulation).

To reveal the spatial characteristics of the multi-scale temporal variation of PsA, we need to perform frequency analyses on multi-scale temporal variations of PsA by using data from high speed optical cameras capable of providing a wide spatial coverage.

For this purpose, we make use of highly sensitive EMCCD cameras, which have been in operation in Sodankyla and Kevo, Finland, Tromsoe, Norway, and Tjautjas, Sweden. All-sky aurora images are taken with the temporal resolution of 0.01 sec. The temporal resolution of these cameras is sufficient to identify the multi-scale temporal variation of PsA. Note that in this study, to make the analysis easily, the images have been down-sampling to 25 Hz.

In the frequency analysis, we have employed all-sky images taken on March 14, 15, and 23, 2018. We computed the average frequency of internal modulation from each pixel of the EMCCD cameras and derived the spatial distribution of their dominant frequencies. Regardless of the magnetic latitude, the luminosity of pulsating patches was fluctuating with a similar frequency. We also derived the frequency spectrum of several pulsating patches existing at different locations in the north-south direction and found that these frequency spectrums of pulsating patches showed peaks at around 3 Hz. These results indicate that the frequency of internal modulation does not depend on latitude, and the frequency of internal modulation is highly collimated on 3 Hz.

Following the method mentioned above, we will also compute the average periodicity of the main pulsation and derive the spatial distribution of main pulsation. In this presentation, we will discuss what factor controls the multi-scale temporal variation of PsA by taking into account their latitudinal and longitudinal dependences.