Pulsation-like variation of Jovian infrared polar emission observed by Subaru 8-m: H3+ and methane emissions

*Yasumasa Kasaba[1], Haruna Watanabe[1], Hajime Kita[2], Chihiro Tao[3], Takeshi Sakanoi[1], Masato Kagitani[1], Orton Glenn[1,4], James Sinclair[4]

1. Planetary Plasma and Atmospheric Research Center, 2. ISAS/JAXA, 3. NICT, 4. NASA/JPL

In the Jovian high-latitude region, there are emissions with various wavelengths ranges, morphologies, and time variations. They are important tracers of energy injection carried by auroral particles that precipitate from the magnetosphere. The polar IR emissions excited in the Jovian upper atmosphere, which include the H_3^+ aurora and thermal emissions of hydrocarbons, reflect not only the abundance of emission sources but also the thermal structures. Both are affected by auroral precipitation into the source region. It is known that, in the polar region inner than the auroral oval, the flux of auroral precipitation can have time variations over various scales from years to seconds.

The H_3^+ aurora observed in near infrared is emitted in thermosphere / ionosphere from thermally excited H_3^+ ions above the CH_4 homopause. Auroral precipitation ionized H_2 and produce H_3^+ ions through ion chemistries. In previous observational studies, the shortest timescale of H_3^+ auroral intensity change was ~30 min, but detected by ~16-min step imaging. We performed the temporal imaging observation of the Jovian H_3^+ IR aurora with Subaru/IRCS and the H_3^+ narrow-band filter on 31 January 2015 and 25 May 2016. The adaptive optics enabled us to see the target with high spatial resolution (~0.2 arcsec). From the images obtained with time resolution of ~150 s on 25 May 2016, we detected a patch-like auroral feature pulsating with a period of ~10 min in noon sector of northern polar region. On the other hand, we could not find any periodic variations from the data obtained on 31 January 2015, which was obtained as slit-viewer image for the other study, and whose time intervals of ~10–30 min every several images was not optimized to this research. In addition, the location where the patch-like emissions observed with high intensities on 25 May 2016 were not so bright on 31 January 2015. The patch-like auroral feature that was pulsating during our observation period on 25 May 2016 have been sometimes observed in UV, but not always. Previous UV observations reported some pulsating auroral features with the periods of ~2–11 min in the northern polar region. However, the locations of them are not consistent with the patch-like feature in this study. The pulsation period of the X-ray aurora, which has a hot spot coinciding with our patch-like IR aurora, is 40–50 min. This region is estimated to connect magnetically to out of the magnetopause, and auroral precipitation there can be caused by dayside reconnection between the Jovian magnetospheric field and interplanetary field.

On the other hand, the hydrocarbon polar emission observed in mid-infrared is emitted from the whole stratosphere. From their locations and morphologies, it is estimated to be related with auroral particles penetrating under the homopause. However, the mechanisms of this link (composition change and/or heating by particle precipitations) are not well understood. Previous studies found the intensity time variation of polar CH_4 emission over days and months. We tried to detect the time variation of CH_4 emission intensity by continuous imaging observations of the northern polar region over several tens of minutes on 31 March, 24 and 25 May 2018 with Subaru/COMICS. We obtained the images using the 7.8 μm filter, which is sensitive to the CH_4 thermal emissions occurring in the pressure range of 20–0.5 mbar and 1 μbar in the Jovian upper stratosphere, with time resolution of ~1 min. On all observation days, the polar region was not bright in 7.8 μm. In addition, we could not find clear time variations of polar CH_4 emission intensity during our observation periods, 25, 50 and 60 min on 31 March, 24 and 25 May 2018.

This observation result is consistent to the model estimation by *Kuroda et al.* [2014], which suggested the relaxation time of hydrocarbon thermal emissions in the Jovian upper stratosphere, where is a possible source region of polar CH_4 emission, is at least ~10^5 s (~28 h).

Keywords: Jupiter, polar emission, H3+, CH4, short time variations

