Pulsation characteristics of Jovian near infrared polar aurora observed by SUBARU IRCS with adaptive optics

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We report the fast pulsation-like characteristics of Jovian near infrared aurora found in our observations by SUBARU imaging using the H_3^+ narrow-band filter (centered at 3.4 μm) with adaptive optics executed in May 2016 associated with Juno's solar wind observation campaign. The observations of Jovian auroras in the ultraviolet (UV) and near infrared (NIR) show the magnetospheric dynamics in their morphology. Radioti et al. (2013) suggested that the UV and NIR auroral emissions generally show similar morphology but still have some differences. Jupiter's UV aurora is the emission from atomic and molecular hydrogens excited by precipitated electrons and has a short timescale of 10^{-2} sec. Some periodic UV emissions with time scales of a few seconds or minutes have observed especially in the polar region. On the other hand, NIR auroral emission is from H_3^+ molecules produced in upper atmosphere through the ionization of H_2 with some ion chemical processes. They are thermalized by ambient atmospheres, and then produce ro-vibrational emissions. As a result, the timescale of NIR auroral emission is longer, with a time scale of 10^2-10^4 sec restricted by the chemical processes [Badman et al., 2014]. None of the observed NIR aurora has significant variations on timescales less than 30 min and they are stable over ~90 min [Stallard et al., 2016] because of their low time resolution and spatial resolution. Although Stallard et al. [2016] reported that the coadded multiple UV images taken over the approximate lifetime of the H_3^+ molecule show similar structures to those observed in the H_3^+ images. Thus, it is assumed that small-scale and rapid variation also may exist in NIR aurora. In this presentation, we report the results of the imaging observation of the Jovian H_3^+ aurora with IRCS (Infrared Camera and Spectrograph) attached on the SUBARU 8-m telescope at Mauna Kea, Hawaii. This observation was done on 25 May 2016 during the approach of the Juno spacecraft to Jupiter. We took the image data of the Jovian H_3^+ lines near 3.4μm using the narrow-band filter. The time resolution was 45-110 sec. During this observation, we utilized the Adaptive Optics instrument (AO188) with the Galilean satellites as guide stars, and achieved spatial resolution of ~0.1 arcsec. We identified the main oval emission, Io's footprint, and some patch-like emissions in the polar region connected to outer magnetosphere or solar wind. On the main oval, dawn side (System III longitude: ~190-210°) was bright and showed the intensity variation with an amplitude of ~20% of the average intensity and a time scale of ~20 minutes, and dusk side (SIII longitude: ~160-180°, called as "discontinuity" in UV observation) is dim and stable. The location of observed main oval corresponded with the footprint of 30 R_j referring to the VIP4 magnetic model (a green line in Figure (a)). Two or three patches were also seen along the main oval. They were sub-corotating and their intensity were varying with different time scales of ~10-17 minutes. In particular, a polar patch appeared in ~62-65° latitude and ~172-182° SIII longitude, marked by blue line in Figure (a), was clearly pulsating with an amplitude of ~35% of the average intensity and the period of ~10 minutes which was identified by Lomb-Scargle method. Figure (b) shows its intensity versus time in minutes, (c) shows the residual intensity with the liner fit (red dotted line) subtracted and (d) shows the periodogram of (c) with confidence levels of 95% and 99% (dashed and dash-dotted lines). The rapid variation of Jovian IR aurora like this was not reported in past. Since the timescale of thermospheric temperature or H_3^+ dynamic transport is expected as 10^4-10^5 sec, these pulsating emissions could be

associated with H_3^+ density changes caused by particle precipitation. In this presentation, we report the detailed analysis results and the estimated energy of the precipitating particles with auroral emission model.

Keywords: Jupiter, aurora, Subaru Telescope