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Horizontal and vertical structures of Jovian IR aurora emission observed by SUBARU / IRCS

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We will report the horizontal and vertical structures of Jovian infrared (IR) aurora observed by SUBARU 8.2m telescope in Feb. 2014 and Jan. 2015. In these observations, we used Adaptive Optics (AO) and achieved high spatial resolution (~170km). This makes it possible to analyze not only horizontal profile but also vertical one (scale height: ~200-400km) of Jovian IR aurora. These observations were held in a framework of Jupiter observation campaign simultaneous with Hisaki/EXCEED.

Jovian magnetosphere, ionosphere and thermosphere are coupled (MIT coupling system) by electric current that generated by fast Jovian rotation. Upper atmosphere extracts the dynamical energy to the magnetosphere through the collisions of neutral and plasma atmospheres and it drives magnetospheric plasma. Such magnetospheric energy is back to the upper atmosphere as electrical current and aurora electrons that causes UV aurora. By these interactions, upper atmosphere is heated and thermally excited H3+ and H2 emit IR aurora. Past K-band spectroscopy showed the different horizontal distributions of H3+ and H2 aurora [Raynaud et al., 2004; Uno, 2013]. In previous emission models of H3+ and H2 lines, it could be originated from the different source altitudes (H3+ from higher and H2 from lower). But our SUBARU/IRCS observation on Dec. 2011, the first Jovian IR spectroscopy with AO, found that H3+ and H2 emissions have similar altitude profile (H2 peaks at 590-720km, H3+ peaks at 680-900km)[Uno et al., 2014]. This is not agreed with past explanations by the altitude difference.

For further pursuit, we performed Jovian IR aurora observation on 13-14 Feb. 2014 and on 30-31 Jan. 2015 by the SUBARU/IRCS (R~10,000) with AO. The former, we observed southern hemisphere and the latter, we observed both hemispheres. While AO was active, we set the slit along the rotational axis to cross the aurora oval vertically. While AO was not active (when Galilean satellites were not at suitable positions), we set the slit along and over the aurora oval to avoid the effect of sliding off of the FOV. At the same time, we took the image of the H3+ in fundamental (v=1-0) line. We acquired the emission lines of H3+ fundamental in L-band (3.2-4.0 um) and H3+ overtone (v=2-0), hot overtone (v=3-1) and H2 (S1) in K-band (2.0-2.4 um) at the same time each in good weather condition. Those enable us to discuss compare spatial distribution, relative intensity and spatial-temporal variations with high accuracy. During this observation, Hisaki/EXCEED tracked Jovian UV aurora emission from the north pole and acquires the information of the flux and energy of precipitating electrons. We try to analyze considering this information.

We have been analyzing the observation data in Feb. 2014 and get follow results (1) H2 emission has lower contrast than H3+ emission at the main oval, (2) the peaks of H2 and H3+ exist similar altitudes. Recently, we try to find out the cause of structures problems by comparison of the horizontal and vertical temperature profiles derived from H2 and H3+ emission.

And we try to H3+ L-band / K-band comparisons about the emission structures and intensities of those for the first time using the fine datasets in Jan. 2015. H3+ is generated through the collisions of precipitating electrons and H2. Since the highly energetic electron can penetrate deeper into the atmosphere, H3+ density and emission intensity may include the information of precipitating electron energy. A theory says that the L-band lines from lower energy states come from lower altitude at lower temperature region than K-band lines from higher altitude at higher temperature region. Using our observation data and Hisaki/EXCEED data, we examine the L-band / K-band emission intensity ratio and response to the precipitating electron energy.

Keywords: Jupiter, aurora, Infrared, spectroscopy