木星電離・中性オーロラ発光の水平・鉛直構造比較：SUBARU/IRCS による補償光学観測

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

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In the Jovian magnetosphere, planetary rotational angular momentum is transported from Jupiter to its magnetosphere and drives magnetospheric plasmas through magnetosphere-ionosphere-thermosphere (MIT) coupling. Magnetospheric energy returns to the polar upper atmosphere by auroral current and precipitating electrons, and heats and ionizes this region. The heated atmosphere excites H3+ and H2 IR aurora. Since H3+ is generated by the ionization of H2 through the collisions with auroral electrons, the emission intensity of H3+ can correlate with both the ionization rate and atmospheric temperature, whereas that of H2 should mainly be controlled by the atmospheric temperature. For these reasons, horizontal and vertical structures of H2 and H3+ IR emissions enable us to separate and compare the horizontal / vertical distributions of ionization and heating in the polar atmosphere associated with MIT coupling processes.

Past K-band (2.0-2.4 um) spectroscopic observations, which obtained H2 and H3+ aurora quasi-simultaneously, shows the difference between H2 and H3+ emission distributions [Raynaud et al., 2004; Uno, 2013]. It could be originated from the different source altitudes, i.e., H3+ emission is from higher altitude where atmosphere is more ionized by auroral electrons and H2 emission is from lower altitude where Joule heating by ionospheric current works more. However, our IR aurora observations by IRCS (Infrared Camera and Spectrograph) attached to SUBARU on Dec. 2011, the first Jovian IR spectroscopy with Adaptive Optics (AO), showed that H3+ and H2 emissions in the northern aurora have similar peak altitude (H2 at 590-720 km, and H3+ at 680-900 km)[Uno et al., 2014]. In our study, the motive is to assess this result by new datasets and also evaluate the horizontal and vertical structures of emission profiles, temperature, and density of the neutral (H2) and ionized (H3+) atmosphere.

The observation was conducted in K-band and L-band (3.2-4.0um) by SUBARU/IRCS on 30 Jan 2015. We used AO which provides high spatial resolution of ~0.1 arcsec (~165km). We obtained H3+ overtone lines (v=2-0), hot overtone lines (v=3-1) and H2 emission lines simultaneously in K-band and H3+ fundamental lines (v=1-0) in L-band. While AO could be used, we set the slit along the rotational axis (crossing the aurora oval vertically). While AO could not be used, we set the slit along and over the aurora oval. At the same time, we took the slit viewer image of the H3+ fundamental line with similar spatial resolution.

We compared the horizontal and vertical structures of H2 and H3+ emission intensities. In horizontal distribution, the emission intensities of both H3+ K-band lines and L-band lines showed clear peak on the aurora oval where electron precipitation is the most active and strong UV aurora is often observed in Jovian disk. However, H2 lines emission intensity does not show similar characteristics, i.e., its flux decreases from limb to lower latitude without clear enhancement at the auroral oval. We also derived the vertical distribution of auroral intensity by onion peeling method. We reconfirmed that the peak altitude of ionized H3+ and neutral H2 emissions are similar (H2 at 600-800 km, and H3+ at 800-1000 km), as the result shown in Uno et al. [2014]. This supports that the observed altitudes of H3+ and H2 are not largely different, and both emissions are from ionosphere-thermosphere coupling region is just where neutral atmosphere are heated and ionized strongly.

We are also deriving the horizontal and vertical distribution of H2 and H3+ temperature and column density. In this paper, we will summarize the horizontal and vertical distributions of emissivity, temperature, and densities of H3+ and H2. Based on this result, we will search the possible scenarios for both the common and difference points of these distributions, and evaluate the ionosphere-thermosphere interactions at the height around the IR aurora emission regions.