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Jovian thermosphere temperature derived from the observation of H_2 and H_3^+ IR emissions

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Abstract

We tried to obtain the reliable measurement of the brightness and temperature distributions of Jovian plasma and neutral upper atmospheres. This region emits the infrared aurora in 2-4 micron from H_2 (neutral) and H_3^+ (plasma). Through these lines, we can get the information of energy injections (by ionospheric electric field and Joule heating) into and momentum transfers (by collisions) between plasmas and neutrals. SUBARU/IRCS observation enable us the measurement of thermospheric temperature.

1. Introduction

Jupiter, the largest planet, has the strongest and largest magnetosphere in the solar system. There have been many attempts to observe the Jovian thermospheric temperature with varying degrees of success. Early spectroscopic studies [1] focused on the determination of the mean H_2 and H_3^+ temperatures or the vertical thermal structure in the auroral region. We have studied this region by numerical simulations [3] and have compared them with the observation data of infrared aurora taken with a ground-based telescope. In our observation at IRTF/CHELL in Aug.-Sep. 2009, we succeeded to get the maps of brightness of Jovian H_3^+ aurora in its 4 um emission line. And we also performed a snapshot of Jovian H_2 aurora at 2.12 um for two nights. Consequently, we clearly detected the obvious morphological difference between H_2 and H_3^+ auroras (see Figure 1, cf. [2]). The origin of this morphological deference is still unknown. It potentially suggests the difference of emission altitude or the difference of energy injection to and the energy transfer between the neutral and plasma atmospheres. In this study, in addition to the emission distributions, we focus on the temperature information to investigate neutral-ion coupling in the Jovian upper atmosphere: How and where does the energy input occur into the neutral and plasma upper atmospheres?

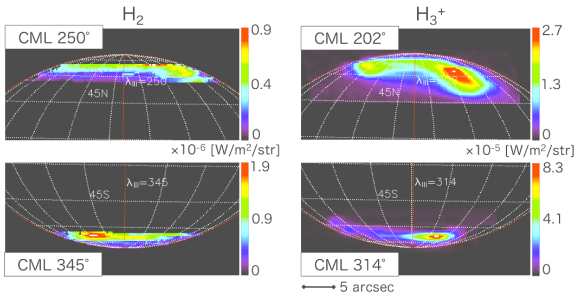

Figure 1: Jovian auroral emission at 2009/9/6. left: H_2 , right: H_3^+ emission respectively.

2. Observation

In Oct. 12 2010, simultaneous H_2 and H_3^+ observations near 2.1 um took place using the SUBARU/IRCS. The slit is set along rotational axis at northern/southern pole. In the polar region, H_2 emission lines $S_1(0)$, $S_1(1)$, and $S_1(2)$ at the wavelengths of 2.22, 2.12, 2.03 um and several H_3^+ emission lines are detected (Figure 2). The wide spectral coverage and the high sensitivity of SUBARU/IRCS enable us the rotational/vibrational temperature measurement from the simultaneous observation of the distribution of emission lines.

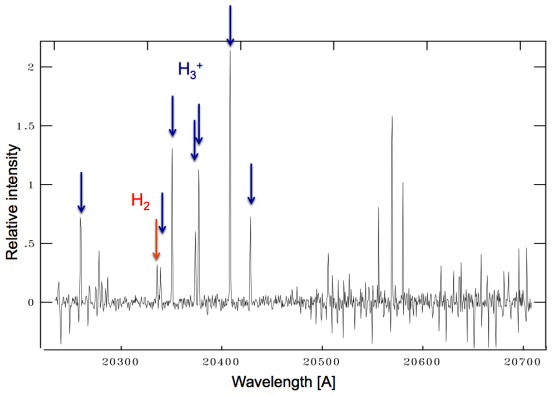

Figure 2: An example of observed spectra. Red arrow indicates H_2 line and Blue indicates H_3^+ lines.

3. Result

Figure 3 shows the line-of-sight integrated emissions of H_2 (top panel) and H_3^+ (middle panel), and also shows the thermospheric neutral temperature (bottom panel) derived from the H_2 emission lines. Almost same morphologies of H_2 and H_3^+ are seen in Figure 3, against the observation in 2009. And, no clearly relationship between the H_2 emission and thermospheric temperature are detected. It seems that the same morphologies of H_2 and H_3^+ are due to the limb brightening effect, or the effect of the CML changes in the time of observation.

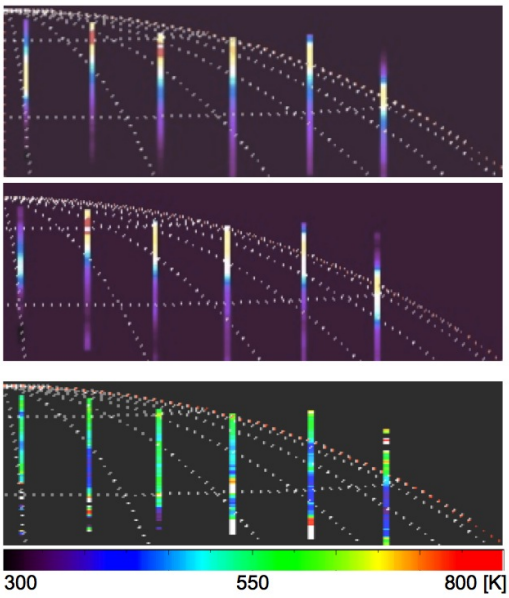

Figure 3: Auroral emissions of H_2 (top), H_3^+ (middle), with the relative scales respectively. Bottom panel shows the thermospheric neutral temperature.

4. Summary and Conclusions

We have measured the distributions of brightness and temperature of Jovian H_2 and H_3^+ using SUBARU/IRCS. No obvious difference of H_2 and H_3^+ morphologies was detected. No clearly relationship between H_2 auroral emission and H_2 temperature was detected. It will tell the heating and energy transfer processes, which connects the Jovian magnetosphere-ionosphere-thermosphere coupling system.

Acknowledgements

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