Investigation of the solar UV/EUV heating effect on the Jovian radiation belt based on radio/infrared observation

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In order to confirm the solar UV/EUV heating effect on the Jovian Synchrotron Radiation (JSR), we made coordinated observations using radio interferometer and infrared telescope. JSR is the emission from relativistic electrons in the Jovian radiation belt, and it is the most effective probe for the dynamics of the Jovian radiation belt through remote sensing from the Earth. It is theoretically expected that the solar UV/EUV heating for the Jovian thermosphere drives neutral wind perturbations, then the induced dynamo electric field increases radial diffusion. The solar UV/EUV heating is also expected to change the brightness distribution of JSR; i.e. the global enhancement of radial diffusion causes inward shift of equatorial emission peak position.

Previous studies confirm that the total flux density of JSR varied corresponding to the solar UV/EUV variations though it is unclear whether the temperature of the Jovian thermosphere actually varied during this event. The purpose of this study is to confirm whether sufficient solar UV/EUV heating occurs on the Jovian thermosphere and it actually causes the variations of the total flux density and brightness distribution. We made coordinated observations of the Giant Metrewave Radio Telescope (GMRT) and the NASA Infra-Red Telescope Facility (IRTF). From the radio interferometer, we measured the total flux density and brightness distribution of JSR. From the infrared spectroscopic observations, we estimated the temperature variations of the Jovian upper atmosphere from H_3^+emission.

The GMRT observations were made from 6th Nov to 17th Nov in 2011 at the frequency of 235/610MHz. The IRTF observations were made from 7th Nov to 12th Nov. We used high spectral resolution spectrometer, CSHELL, and observed H_3^+ Q(1,0-) 3.953 microns emission. Slit position was located along the sub-solar point and dusk side limb. During the period, solar UV/EUV flux variations expected on Jupiter increased monotonically. The GMRT 610 MHz observation shows that the total flux density increased from 6th Nov to 13th Nov by about 5%, corresponding to the solar UV/EUV variations. The IRTF observation shows that equatorial H_3^+ emission also increased from 7th Nov to 12th Nov by 20-30%, that is, temperature at the equatorial region was expected to increase. On the other hand, radio images showed that the equatorial emission peak position moved outward by 0.2 Jovian Radii.

These observation results showed that the variation of JSR at this time was caused by not global but non-uniform enhancement of radial diffusion. This non-uniform change can be explained by a numerical simulation study of the Jovian upper atmosphere. It is expected that temperature variations induced by the solar UV/EUV enhancement propagate from the auroral latitude to the low latitude region. These temperature variations cause enhancement of radial diffusion at the outer region which shift the equatorial peak position outward. Hence, we propose the scenario that radial diffusion increased not globally but locally at the outer region only around L=2-3 during this period.

The further confirmation of the solar UV/EUV heating effect on the Jovian radiation belt is deferred to future studies in ground-based observations. Detail mapping of H_3^+ emission and daily base observation is necessary to confirm that the temperature variations actually propagate from the auroral latitude to the low latitude region. In addition to that, temperature measurement using intensity ratio of H_3^+ emission line is needed for more reliable results.