太陽紫外線による熱圏大気加熱が木星放射線帯に及ぼす影響　-電波・赤外望遠鏡観測にもとづく考察-

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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 investigate atmospheric heating effect by the solar UV/EUV on the Jovian radiation belt (JRB), we made coordinated observations using radio/infrared telescope. Jovian Synchrotron Radiation (JSR) is emitted from relativistic electrons in the JRB, and it is the most effective probes for the dynamics of the JRB. It is theoretically expected that the solar UV/EUV heating for the Jovian thermosphere drives neutral wind perturbations, then the induced dynamo electric field causes enhancement of the radial diffusion globally. This global enhancement is also expected to cause inward shift of equatorial emission peak.

Previous studies confirm that the total flux density of JSR varied associated with the solar UV/EUV variations, however it has not been confirmed whether the temperature of the Jovian thermosphere actually varied during the event. The purpose of this study is to examine 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 observations, we measured the total flux density and brightness distribution of JSR. While, 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 frequencies of 235 and 610MHz. The IRTF observations were made on 7th Nov. and 11th Nov., using high spectral resolution spectrometer, CSHELL, for H_3^+ Q(1,0-) 3.953 microns emission. The slit position was located along the sub-solar point to dusk side limb direction. 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 11th Nov. by 20-30%, suggesting the enhancement of temperature at the equatorial region. On the other hand, the derived radio images showed that the equatorial emission peak position moved outward by about 0.2 Jovian radii.

These observation results could be explained by not global but radially localized enhancement of inward diffusion. It is expected from a numerical simulation study of the Jovian thermosphere that temperature variations induced by the solar UV/EUV enhancement propagate from the auroral latitude to lower latitude region. The radial diffusion may depend on the invariant latitude because of the propagation effect. These temperature variations may increase radial diffusion non-uniformly and make apparent outward shift of the equatorial peak position.

In addition to that, increase of radial diffusion was smaller than the previous observations. Bhardwaj et al., (2009) reported that total flux density changed from 5.3 to 6.5 Jy from the GMRT observation in 2003, while solar EUV flux changed from 3.3 to 4.0 x10^{10} photons/cm^2/s. The equatorial peak position moved inward during this enhancement. On the other hand, our result showed that total flux density changed from 4.4 to 4.8 Jy while solar EUV flux changed from 3.8 to 4.2 x10^{10} photons/cm^2/s. By comparing these two cases, it is suggested that inward shift of the equatorial peak position is caused by the large increase of radial diffusion which was caused by the solar EUV enhancement. Therefore, due to the small enhancement of radial diffusion, the changes of total flux density were small in 2011. Because radial diffusion process causes hardening of the JSR spectrum, we have analyzed 235 MHz data obtained in 2003/2011 and compared the spectrum changes of these two cases.