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Short-term variation of Jupiter's extended sodium nebula: Io's ionospheric control of east-west asymmetry of the sodium nebula

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Ground-based optical observations of D1 and D2 line emissions from Jupiter's sodium nebula, which extends over several hundreds of Jovian radii, were carried out at Mt. Haleakala, Maui, Hawaii using a wide field filter imager from May 19 through June 21 in 2007 and from June 29 through July 10 in 2008. During these observations, the east-west asymmetry of the nebula with respect to the Io's orbital motion was clearly identified. Particularly, the D1 + D2 brightness on the western side of Jupiter is strongly controlled by the Io's orbital motion. The following scenario was developed to explain this phenomenon as follows: First, More ionospheric ions like NaX+ which are thought to produce fast neutral sodium atoms due to a dissociative recombination process, are expected to exist in Io's dayside hemisphere rather than in the nightside one. Second, it is expected that more NaX+ ionospheric ions are picked up by the Jovian co-rotating magnetic fields when Io's leading hemisphere is illuminated by the Sun, Third, the sodium atom ejection rate varies with respect to Io's orbital position as a result of the first two points. Model simulations were performed using this scenario. The model results were consistent with the observation results. In fact, dependence of Io's ionospheric electron density on the Io's local time was identified during Galileo mission. In addition to the Galileo mission's results, our results indicates that Io's ionospheric ion density is also expected to be controlled by solar radiation just like Earth.