

Variations of Io's volcanic activity seen in Jupiter's extended sodium nebula

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Io, which is one of the Galilean moons of Jupiter, is the most volcanically active body in the Solar System. Volcanic atmosphere is ionized and picked-up by Jupiter's co-rotating magnetic fields. This plasma distributes in Jupiter's inner magnetosphere and forms a structure called Io plasma torus. Major constituents in the torus are sulfur and oxygen ions, and most of these ions have emissions lines at UV wavelengths. Although this is a minor constituent, NaCl⁺ should be included in the torus since Cl⁺ ions were detected from the ground, and neutral sodium atoms show the most distinct emission at sodium D-line wavelengths in the torus. Not only in the torus, sodium emission can be observed also in a vast region whose extent is 1,000 Jupiter's radii around Jupiter. This structure is called Jupiter's sodium nebula, or Mendillo-sphere. This means these sodium atoms have enough velocity to escape from Jupiter's and Io's gravitational-spheres.

These sodium atoms seem to be originated from sodium chloride in Io's volcanic gas. This gas becomes Io's ionospheric plasma. Pick-up of these NaCl⁺ ions from Io's ionosphere and their subsequent destruction in the plasma torus produces fast flow of neutral sodium atoms, then Jupiter's sodium nebula is formed. This sodium nebula can be observed from the ground using small telescopes.

We have been making observations of Jupiter's sodium nebula atop Haleakala in Maui island, Hawaii, and found the nebula shows variations that seem to correspond to those in Io's volcanic activity. Since 2013, we have been making the observations in conjunctions with the Hubble and Juno spacecraft. The most distinct event during this campaign was seen in 2015. Other than this, several minor enhancements were observed.

In this presentation, we will show latest sodium data that is representative of Io's volcanism. Also, comparisons of the sodium data with Hubble's torus data and Io's infrared observations will be shown.

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