Relation between volcanism on Jupiter moon Io and the atmosphere and plasma torus observed by ALMA and Hisaki

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In this study, we try to find effects of volcanism to generate the Io’ s atmosphere. Io’ s atmosphere is thin (several nbar) and is dominated by SO_2 (~90%). Oxygen and sulfur atoms in the upper atmosphere are escaped and ionized, and then generate Io plasma torus around Io’ s orbit. Io’ s volcanism can be classified in two types. One is effusive eruption. Lava directly flows out of a volcano and onto the ground. The other is explosive eruption. Gases in the magma under volcanoes suddenly froth, and are ejected SO_2 -rich gas through the volcanic vent (called plume). In powerful volcanoes such as Loki and Pele, lava eruptions sometimes accompany with plume. It is still unknown which type of eruptions emit gasses enough to change the profile of Io’ s atmosphere and Io plasma torus.

We demonstrated the spatial and velocity distribution of Io’ s SO_2 atmosphere by analyzing the ALMA (Atacama Large Millimeter/Submillimeter Array) archive data (~332-346 GHz) observed on 20 March 2018. We found the presumed volcanically active areas in the east side and northern high latitude region (Volcano 1) and in the west side near the equator (Volcano 2). In Region 1, high and low velocity components are clearly identified in the velocity distribution before ingress. The Doppler shift of the high velocity component relative to the low velocity is ~0.6 km/s (red shift). The result suggests the significant volcanic plume generated atmospheric dynamics and supply SO_2 gases to the upper atmosphere. In Volcano 2, we could not detect the high velocity component of SO_2 gas. The rotational temperature of SO_2 is 311±41 K after ingress, much higher than temperature of sublimation atmosphere (~100-200 K). It might reflect the temperature of low velocity gases which are emitted from volcanoes or/and heated by a hot lava lake in Volcano 2.

We also observed the enhancement of Io plasma torus on the dusk side by Hisaki satellite with the ultraviolet spectrometer EXCEED in the same period of the ALMA observation. The result suggests the direct volcanic input of SO_2 gases may trigger the enhancement of Io plasma torus. We detected gases that may be emitted by effusive and explosive eruptions from the ALMA archive data simultaneously. However, we need further observation by Hisaki and ground-based telescope to clarify which type of eruptions contribute to enhance Io plasma torus.

Keywords: Planetary volcanism, Jupiter moon Io, Atmosphere, Io plasma torus

