



Variability of Io plasma torus before and during the Juno era

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Volcanic gases, primarily composed of SO₂, SO, and S, originating from Io are ionized through interactions with magnetospheric plasma, forming a dense plasma region known as the Io plasma torus. Ion pickup serves as the most significant energy source for the plasma torus though, the spatial distribution of the pickup region and its temporal variability remain poorly understood. Measuring ion distributions with sufficient spatial resolution enables the derivation of ion temperatures and temperature anisotropy, being closely related to the influx of fresh pickup ions.

Since 2014, we have carried out ground-based observations of sulfur ion emissions ([SII] 671.6 nm and 673.1 nm) from the Io plasma torus at the Haleakal Observatory in Hawaii, utilizing Tohoku 60-cm telescope. The telescope is equipped with a monochromatic imager and a coronagraph, enabling us to observe the distribution of singly charged sulfur ions with a spatial resolution as fine as 0.03 Jovian radii. This unique setup has allowed us to track changes in the torus structure with high spatial and temporal precision.

Over the past six years, our observations revealed five significant peaks in [SII] brightness. For three of these events, we observed that the [SII] ribbon scale height began to increase shortly after the brightness peaks. This phenomenon likely indicates a rise in ion temperature, driven by volcanic outbursts on Io that introduce fresh ions into the torus. Such findings provide critical insights into the dynamic nature of the Io plasma torus and its response to volcanic activity.

In this presentation, we will review past and ongoing remote sensing projects, present the latest observational results from our multi-year campaign, and discuss future plans for supporting upcoming space missions.