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Initial Modelling of a New High-Speed Atmospheric Escape Process at Io

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Abstract

High-resolution spectra of Io sodium have identified an unexpected high- speed ejection process operating near Io's wake and Jupiter-facing hemisphere. Observations in 2007 with the SARG spectrograph on the 3.6-m Telescopio Nazionale Galileo in the Canary Islands targeted Io as it neared eclipse behind Jupiter (Figure 1).

Our spectra of Io in the hour before eclipse revealed an unexpected signature of high-speed atmospheric escape distinct from the red-shifted "jet" and "stream" directed in the anti-Jupiter sense. The new feature is clearly blue-shifted, indicating ejection from Io towards Jupiter (Figure 2). Observations in 2009 confirmed the Jupiter-directed ejection with Io near superior conjunction with Jupiter. Preliminary analysis indicates that the source process is not active immediately after eclipse, suggesting the mechanism is reduced by atmospheric collapse or the lack of of photoionization.

The observed directionality and speeds exceeding 10 km/sec indicate a source process involving fields and currents in Io's atmosphere and/or wake, as opposed to the lower speeds and more isotropic ejection expected from collisions. At present there are no known ejection mechanisms that satisfy the observed properties.

We will present empirical models of the escaping sodium designed to constrain the geometry, velocity and timing of the escape process with the intention of identifying a causal mechanism in the plasma interaction at Io.

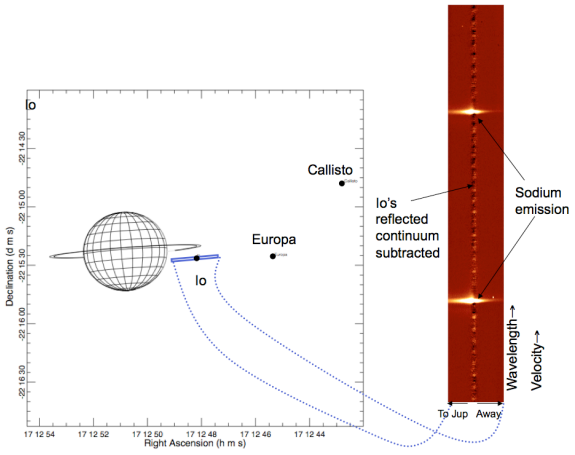

Figure 1: The observations targeted Io when close to conjunction with Jupiter, allowing accurate determination of Doppler shifts in the radial direction.

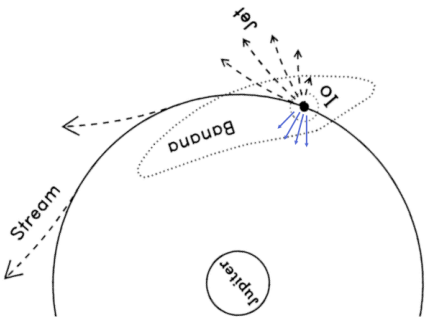

Figure 2: The newly-discovered escape process differs from other known processes in that that sodium atoms are ejected towards Jupiter.

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