Azimuthal variability and subcorotation in the Io plasma torus as observed by Cassini UVIS

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From 01-Oct-2000 to 14-Nov-2000 the Ultraviolet Imaging Spectrograph (UVIS) aboard the Cassini spacecraft obtained 1,904 spectrally-dispersed images of the Io plasma torus. Using the CHIANTI atomic physics database, we have derived the ion composition of the torus at the dawn and dusk ansae for each image. During this period, we find that the Io torus exhibited significant azimuthal variations in ion composition. We find the mixing ratios of the two major ion species, S III and O II, to be anti-correlated. The mixing ratio of the minor species, S II, is correlated with S III and anti-correlated with S IV. For observation periods of up to ~100 hours, we find that the azimuthal variations in plasma composition are well-fit by a simple, single-peaked sinusoidal function with a period equal to that of the System III (1965) rotation period of Jupiter. By fitting the UVIS observations within a 50-hour sliding window with this sinusoidal function, we find that the phase of the azimuthal variation increases roughly linearly with time. The slope of the phase increase is consistent with plasma that is subcorotating by 1.4% (~1 km/s at the orbit of Io). In addition to the phase increase, we find that the amplitude of the azimuthal compositional asymmetry varies with time. For the minor ion species of S II and S IV, the amplitude varies between 5-20%, while the major ion species of S III and O II remain relatively constant with amplitudes ranging between 2-5%. This amplitude of the azimuthal compositional asymmetry appears to be modulated by the System III longitude of the plasma, such that when the peak in the S II mixing ratio (and correspondingly, the minimum in S IV) is aligned with a System III longitude of ~200°, the amplitude is greatest.