Final Report
for

NASA Grant NAG5-6909
"EUVE Observations of the Jupiter System"

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Abstract

This document is the final report for NASA Grant NAG5-4615, "Satellie Atmosphere and Io Torus Observations", Nicholas M. Schneider, P.I., awarded to the University of Colorado, 8/1/97-3/31/00. The grant was originally awarded to Dr. Doyle T. Hall, who left the University of Colorado before the completion of the project.

Results from NAG5-6909

Io is the most volcanically active body in the solar system, and it is embedded deep within the strongest magnetosphere of any planet. This combination of circumstances leads to a host of scientifically compelling phenomena, including (1) an atmosphere out of proportion with such a small object, (2) a correspondingly large atmospheric escape rate, (3) a ring of dense plasma locked in a feedback loop with the atmosphere, and (4) a host of Io-induced emissions from radio bursts to UV auroral spots on Jupiter. This proposal seeks to continue our investigation into the physics connecting these phenomena, with emphasis on Io's atmosphere and plasma torus. The physical processes are clearly of interest for Io, and also other places in the solar system where they are important but not so readily observable.

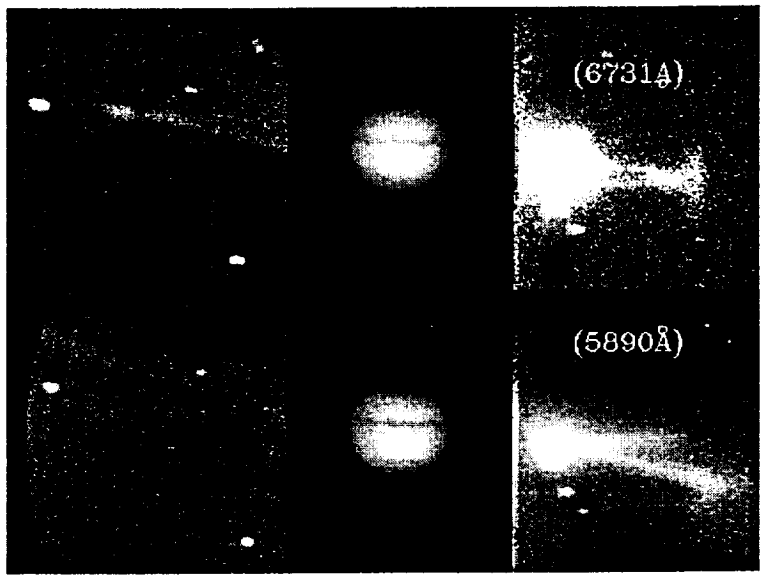

Figure 1: Groundbased images of Io's escaping atmosphere (bottom) and the resulting torus of plasma encircling Jupiter (top). The bottom image shows neutral sodium; the appearance of the cloud reflects the many processes which cause atmospheric escape. The top image shows S^+; the structure reveals the combined effects of mass and energy supply. The ring is tilted due to the tilt of Jupiter's magnetic field. These observations were made in collaboration with J.T. Trauger during a previous funding cycle for our program.

Twenty-five years of groundbased observations and a handful of interplanetary and Earth-orbiting spacecraft have given an adequate general picture of Io's atmosphere and torus (reviewed by Spencer & Schneider 1996). Io's volcanism pumps sulfur dioxide and other species onto the surface and into its atmosphere. These materials escape Io's weak gravity by several mechanisms and form extended "neutral clouds" around Io orbit (Figure 1, bottom). The atoms and molecules are ionized by the plasma, and are swept into a ring

by Jupiter's rapidly rotating magnetic field (Figure 1, top). The plasma, along with its concomitant electric and magnetic fields has a remarkably strong interaction with Io, leading to a variety of excitation and escape processes in Io's atmosphere.

The EUVE satellite is capable of observing the Io plasma torus at the extreme UV wavelenths where it emits the majority of its energy. This allows critical tests of theories of torus energy supplies, especially when compared with observations at other wavelengths. This was the focus of our work with the small remaining fraction of remaining funds after the departure of Dr. Hall.

The figures below show the progressive analysis from spectrum (Figure 2) to monochromatic torus image (Figure 3) to EUV longitudinal variation (Figure 4). The project has culminated in a rigorous comparison of longitudinal variations at other wavelengths from simultaneous observations (Figure 5). EUV variations are smaller than those observed at other wavelengths. This result is the key result of a paper nearing submission: "*Non-thermal electrons and their effect on Io plasma torus emissions*" by Nicholas M. Schneider, Michael Küppers Melissa A. McGrath, Doyle T. Hall, andA. Ian F. Stewart. The paper will be submitted to the Journal of Geophysical Research.

Figures.

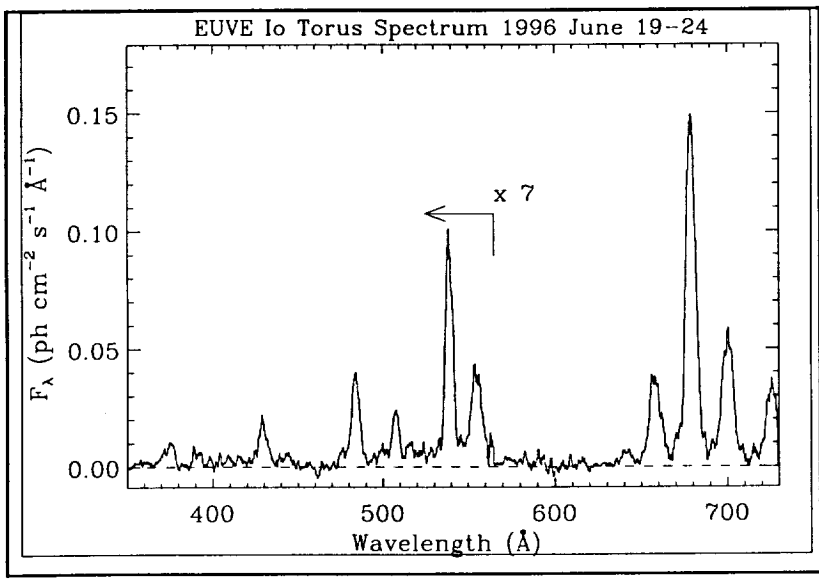

Figure 2. Spectrum of the Io plasma torus obtained with the EUVE spacecraft

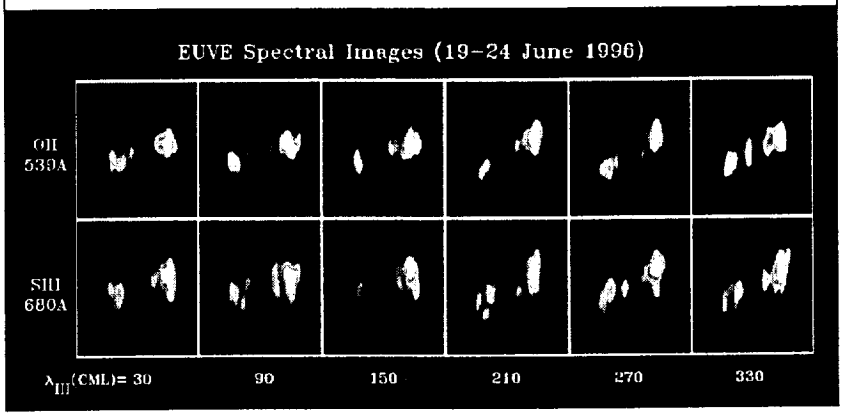

Figure 3. Images of the Io plasma torus created by extraction of emission at the specific wavelengths of known spectral features. Note the changing tilt of the torus observed as the planet rotates. Also note the lack of large intensity variations seen as the torus rotates.

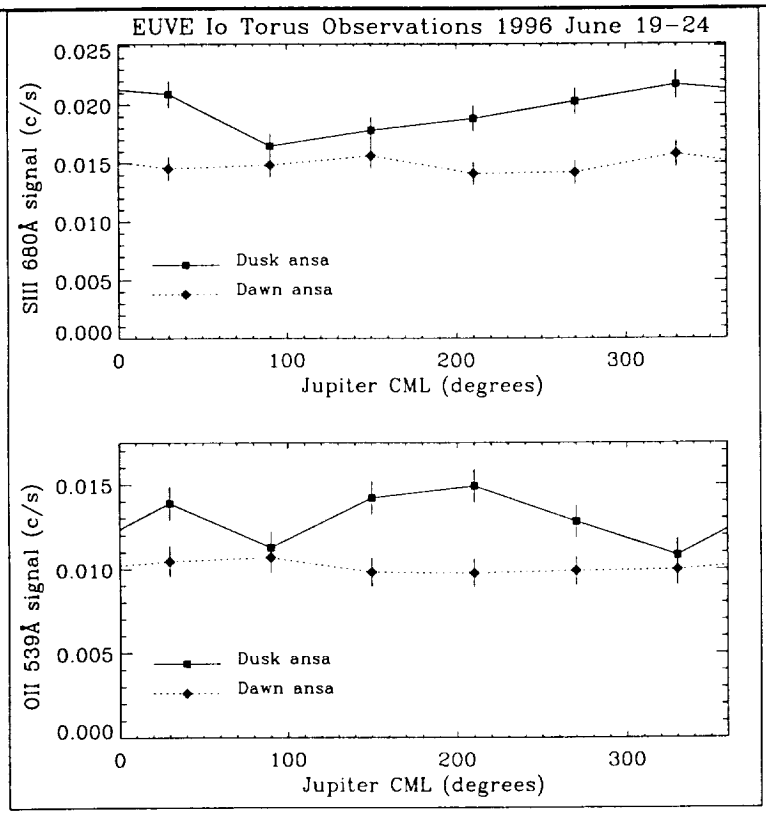

Figure 4. Intensites of the torus emissions as a function of magnetic longitude, confirming the lack of large systematic variation seen in the previous figure.

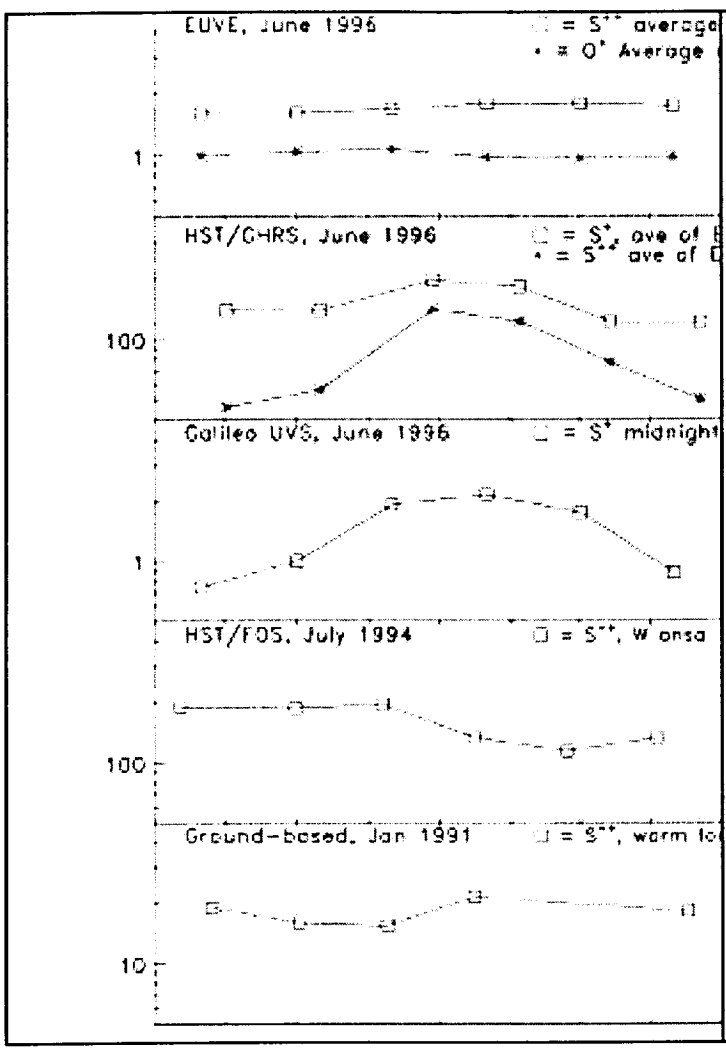

Figure 5. Comparison of longitudinal intensity variations vs. magnetic longitude in different wavelength regimes. Note that small EUV variation compares to UV or optial variations. This result is central to "*Non-thermal electrons and their effect on Io plasma torus emissions*", Schneider et al., where this figure will appear.