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The EUV spectrum of the Venus dayglow: observations during the Cassini Venus flyby

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Abstract

We present the analysis of EUV spatially-resolved dayglow spectra obtained at 0.37 nm resolution by the UVIS instrument during the Cassini flyby of Venus, a period of high solar activity level. Emissions from OI, OII, NI, CI and CII and CO have been identified and their disc average intensity has been determined. They are generally somewhat brighter than those determined from the observations made with the HUT spectrograph at a lower activity level, We analyze the brightness distribution along the foot track of the UVIS slit of the OII 83.4 nm, OI 98.9 nm, Lyman-ß + OI 115.2 nm and NI 120.0 nm multiplets, and the CO C-X and B-X Hopfield-Birge bands. We make a detailed comparison of the intensities of the 834 nm, 989 nm, 120.0 nm multiplets and CO B-X band measured along the slit foot track on the disc with those predicted by a detailed airglow model. This model includes the treatment of multiple scattering for the optically thick OI, OII and NI multiplets. It is found that the calculated intensity of the OII emission at 83.4 nm is somewhat larger and the limb brightening more pronounced than predicted by the model. The calculated intensity variation of the CO B-X emission along the track of the UVIS slit is in fair agreement with the observations. The calculated brightness of the NI 120 nm multiplet is larger by a factor of ~2-3 than observed.

1. Introduction

The Cassini spacecraft flew by Venus on 24 June 1999 to gain gravitational assist on its way to Saturn. At this period, solar activity was rising, reaching a F10.7 solar index ~214 at Earth distance. The UVIS spectrograph [1] obtained a series of simultaneous FUV and EUV spectra during this swingby. Fifty-five records of 32s each were obtained along the track, twenty-five of which observed the sunlit disc of Venus. The latitude of the UVIS slit footprint on the planet varied from ~24° North to ~15° South. Figure 1 shows the foot track geometry and describes the variation of the solar zenith angle (SZA) and emission angle (the angle between the line of sight and local zenith at the altitude of airglow emission). The SZA varied along the track from 90° at the morning terminator to 0° when the UVIS line of sight reached the sunlit planetary limb.

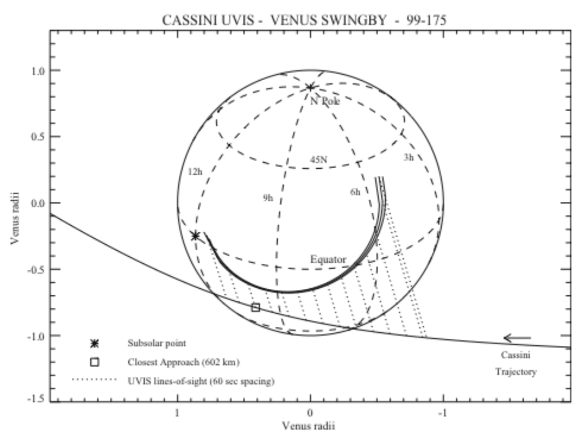

Figure 1: geometry of the UVIS observations during the Venus flyby by Cassini.

2. Disc spectrum

Features belonging to OI, OII, HI, NI, CI and CO are identified (Figure 2) based on the wavelength list for atomic transitions [4] and guided by the HUT Venus spectrum [2] and the high-resolution (0.02 nm) spectrum of Mars obtained with the Far Ultraviolet Spectroscopic Explorer (FUSE) satellite [3]. We shall report the intensities of several UVIS emissions measured across the disc, averaged to determine the average disc emission rates. They range from 261 R for the O^+ 83.4 nm emission down to a few Rayleighs for the weaker emissions. The emissions from 112.0 to 130.0 nm are affected by the very intense Ly-α wings.

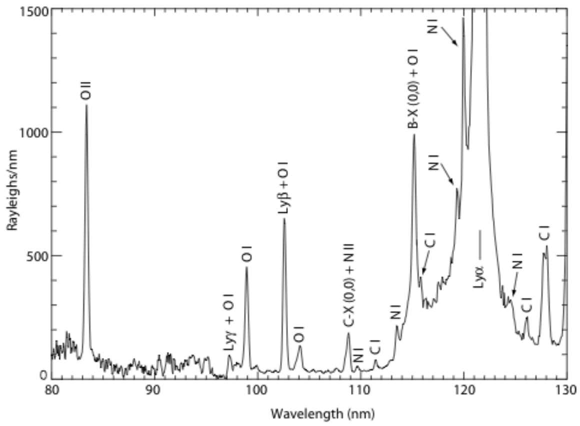

Figure 2: average EUV dayglow spectrum obtained by the UVIS spectrograph. Various atomic lines and molecular bands are identified and will be discussed.

3. Comparison with model calculation

A numerical model is used to calculate the photoelectron production and energy degradation in the Venus atmosphere. The Direct Simulation Monte Carlo (DSMC) method is used to solve atmospheric kinetic systems in the stochastic approximation. Many of the emissions identified in the UVIS spectra are optically thick. The effect of multiple scattering on the 83.4 nm, 98.9 nm and 120.0 nm optically thick emissions is calculated using a resonance line radiative transfer code. In this study, we model the brightness distribution across the disc for those emissions which are bright enough to yield a reliable signal to be compared with the model output. For this reason, we concentrate on the emissions of O^+ at 83.4 nm, the OI multiplet at 98.9 nm, the NI multiplets at 113.4, 120, and 124.3 nm and the Hopfield-Birge B-X (0-0) and C-X (0-0) bands.

The observed emissions are generally somewhat brighter than those determined from the observations made with the HUT instrument. The difference is attributed to the higher solar activity prevailing during the Cassini flyby in comparison with those during the HUT observations. A discussion of the comparison with model calculations will be presented.

Acknowledgements

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