UV Emission Lines in FOS Sky Spectra

R.W. Lyons [1], W.A. Baity [1], R.D. Cohen [1], V.T. Junkkarinen [1]

I. Motivation

Although sky light is recorded during exposures with the FOS, concurrent sky measurements are not made. Sky continuum background light during the *HST* nighttime arises mainly from zodiacal light and diffuse galactic light and can be corrected with reasonable confidence. The sky background can be quite variable for daytime exposures and has been detected in the UV down to ~1500Å on a number of occasions. The sky background increases in significance as one moves to longer wavelengths, becoming most significant at visible wavelengths. As well as a continuum contribution, there are a number of emission lines, mostly from hydrogen, oxygen and nitrogen species. Most of the lines show up at visible wavelengths and their presence, albeit rather erratic, appears to be limited to daytime observations. A few, however, occur in the UV and may have some impact on the interpretation of UV spectra, and it is to these UV lines that this contribution is devoted.

This work is based on three Science Verification tests, SV2965, SV2966 and SV2967, made to determine the nature and significance of the sky contribution in FOS spectra. Various aspects of these tests have been discussed previously in Lyons et al. (1992, 1993a and 1993b).

II. Observations

Exposures of seventy sky fields were made using the G160L grating and the Blue Digicon of the FOS between early 1991 and early 1992. During the same time period, exposures of 68 other sky fields were obtained with the Red Digicon using the G160L and G650L gratings as well as the prism. The FOS target aperture, a 4.3″ square, was used for all exposures. Any field which inadvertently contained a bright discrete source could be identified by examining the line spread function of the zero order spectrum obtained as part of the G160L and G650L exposures. Data from these fields are not included in the results presented here.

III. Discussion

Geocoronal Lyα and O I have been discussed previously (cf. Lyons et al. 1993a). As shown in Figure 1, the line strengths, expressed in counts sec^{-1} $pixel^{-1}$, depend mainly on the angle between the Sun and the Earth as seen from the spacecraft (the Sun-Earth angle or SEA). Lyα is always present while O I is only seen during the

1. University of California, San Diego, CASS, La Jolla, CA 92093-0111

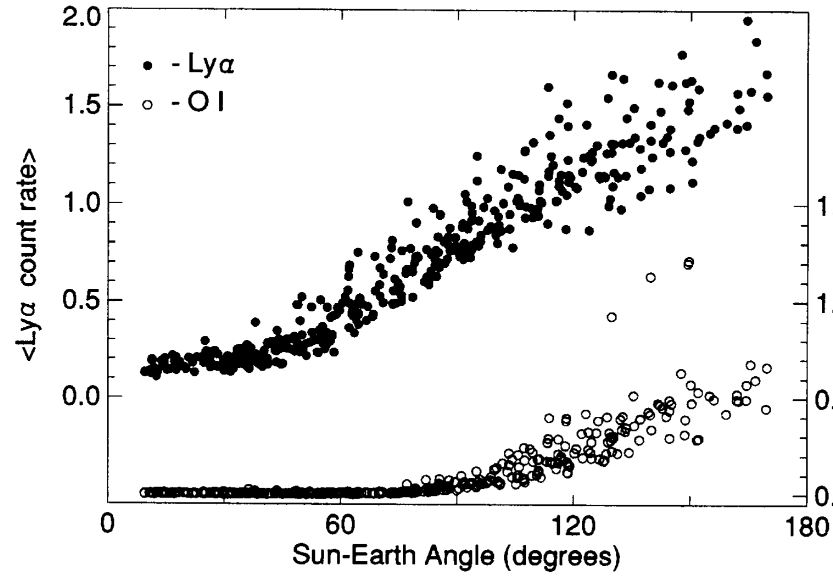

Figure 1: G160L Blue - Emission Line Strengths

daytime (SEA > 66 °). On one run during a period of intense solar activity , unusually high O I rates were detected (Lyons et al. 1993a). Some of the scatter at any particular Sun-Earth angle results from a secondary dependence on the Earth-target angle or ETA, the angle between the center of the Earth and the target as seen from the spacecraft. Both of these lines were expected and their behavior is fairly predictable.

The behavior of other UV lines, one at ~2137Å , one at 2470Å previously identified as [O II] (Kinney 1993), and one at ~2802Å is much more erratic. Based on the position of the telescope when these emission lines appear , it seems that they , like the

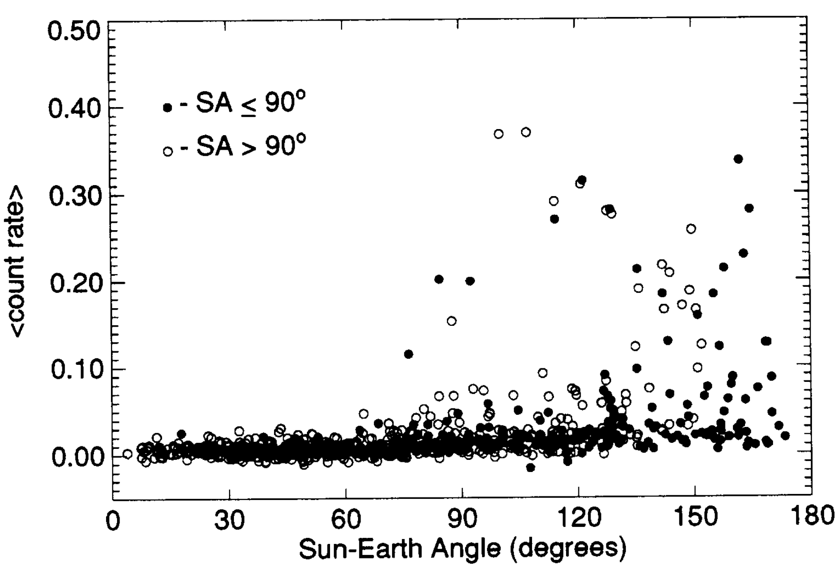

Figure 2: Relationship of [O II] count rate and SEA for prism spectra.

emission lines seen in the visible, occur exclusively during daytime exposures. However , they are absent on most of the daytime spectra taken. Since the large aperture was used for these exposures, the lines are very broad and their presence at low levels cannot be ruled out.

The line at 2137Å was evident on at least one prism spectrum in which the [O II] λ2470 line is also present. The sensitivity of the prism configuration this far into the UV is very poor . It is clearly seen on several of the G160L spectra taken with the Red detector .

Of these three UV lines, [O II] λ2470 is detected most often. When the count rate above the local continuum short of the line is plotted against SEA (Figure 2), it is apparent that the rate is elevated significantly above zero only during the *HST* daytime. Other than that there is no correlation with this angle. There is also no correlation with the Sun angle, SA (angle between the Sun and target as seen from the telescope), which is approximately constant for any observation run. A plot of the count rate against the Earth-target angle (Figure 3) does show a correlation, in the sense that higher rates are recorded for angles nearly tangential to the orbit, although it is apparent that at least one other factor is involved.

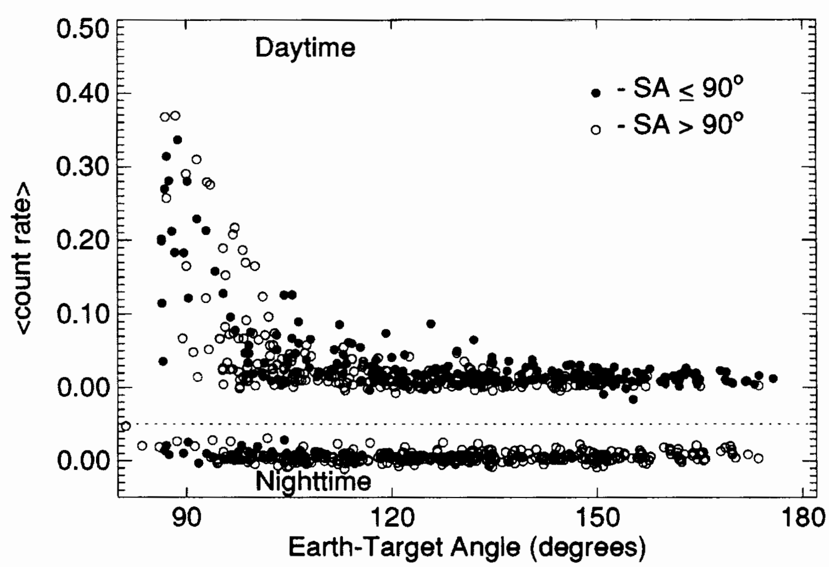

Figure 3: Relationship of [O II] count rate and ETA for prism spectra.

The available data on the third line, 2802Å, is sparse but a plot of the count rate against the Earth-target angle (Figure 4) suggests a correlation similar to that for the [O II] line. W e suggest that this line is Mg II.

IV. Example

As a caution to other observers, we offer the following real life example. Figure 5a shows the total counts obtained plotted against wavelength for two consecutive exposures of a QSO taken with the Red Digicon and the G270H grating through the target acquisition aperture. The exposures were made entirely during the *HST*

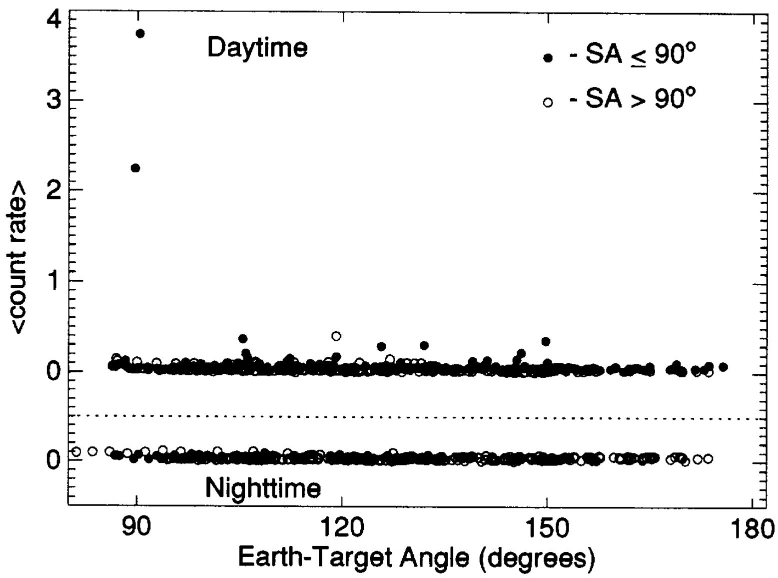

Figure 4: Relationship between 2802 A line and ETA from prism spectra.

daytime but on different orbits. Notice that the strengths of the emission features at 2470Å and 2802Å are consistent between the two exposures. Each exposure consisted of 12 sub-exposures. Two sub-exposures separated by about 7 minutes are shown in Figure 5b. The variation in the emission lines is clear. If this variation had been due to noisy channels, the number of pixels affected would have been different. The exposure time per pixel is indicated in the figure.

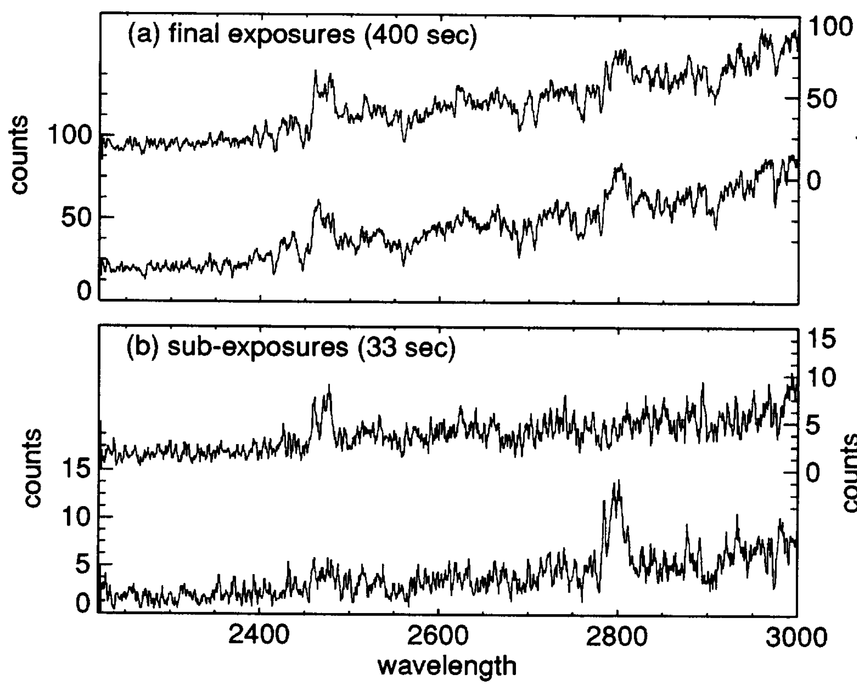

Figure 5: Sky lines in QSO exposures (G270H Red detector)

To the best of our knowledge at the moment, problems of this nature are restricted to the daytime portion of an observation. Further study is required to confirm whether this is correct. We note that the observations shown occurred at Earth-target angles above 114°, angles above those expected to produce any major problem based on the prism sky data.

Acknowledgments

This work was supported by NASA — NAS5-29293 and NAG5-1630.

References

Kinney, A. 1993, "Faint Object Spectrograph Instrument Handbook Version 4.0," Space Telescope Science Institute.

Lyons, R.W, Baity, W.A., Beaver, E.A., Cohen, R.D., Junkkarinen, V.T., Linsky, J.B. 1992, "Faint Object Spectrograph On-Orbit Sky Background Measurements," FOS Instrument Science Report CAL/FOS-083 (preliminary).

Lyons, R.W, Baity, W.A., Beaver, E.A., Cohen, R.D., Junkkarinen, V.T., Linsky, J.B., Bohlin, R.C. 1993a, "On-orbit sky background measurements with the FOS," in SPIE Proc. "Space Astronomical Telescopes and Instruments II," ed. P. Bely and J. Breckinridge (Bellingham, WA: SPIE), 1945 (in press).

Lyons, R.W., Baity, W.A., Beaver, E.A., Cohen, R.D., Junkkarinen, V.T., Bohlin, R.C.1993b, "Sky Background for the *HST*'s Faint Object Spectrograph," BAAS, 25, 1246.