I. INTRODUCTION

The solar H i La (1215.67 Å) intensity profile has been recorded on photographic emulsion in 1962 (Tousey 1963; Tousey et al. 1964), in 1966 and 1967 (Bruner and Parker 1966; Bruner and Rense 1969), in 1972 (Bruner et al. 1973), in 1973 (Nicolas et al. 1976), and in 1975 (Bartoe et al. 1976; Bruns et al. 1976). Only recently have photoelectric profiles been measured (White et al. 1976). However, no average solar Lyman flux profile, i.e., the integral over the full disk, has been derived from these observations.

In the case of the solar H i Lß (1025.72 Å) line, the intensity profile has been recorded on photographic emulsion in 1962 (Tousey 1963 and Tousey et al. 1964, 0.07 Å spectral resolution), in 1973 (Nicolas et al. 1976, Skylab SO 82 slit spectrograph, 0.1 Å spectral resolution), and in 1975 (Bruns et al. 1976, OST, Salyut 4, 0.1 Å spectral resolution). Here also no attempt has been made to deduce the full disk solar profile.

We note that the flux profile is of interest not only in stellar spectroscopy but also in cometary physics and aeronomy.

In solar physics both profiles are used as a diagnostic (with La and other Lyman-series lines) to infer the existence and average extent of a temperature plateau in the transition zone. Furthermore, the Lß wavelength is almost coincident with the O i 1025.77 Å line and is responsible for a pumping process which may increase the strengths of a number of other oxygen lines (Haish et al. 1977). Observations of the O i emission line from comet Kohoutek have been attributed to this mechanism (Feldman et al. 1976). In the geocorona the solar flux at the Lß line core produces Hα airglow (Brandt and Chamberlain 1959; Tinsley and Meier 1971; Levasseur, Meier, and Tinsley 1976).

II. OBSERVATIONS

The Laboratoire de Physique Stellaire et Planétaire (LPSP) instrumentation on board the pointed section of OSO 8 is a high-resolution spectrometer coupled with a Cassegrainian telescope with a 16 cm aperture. Taking into account the spacecraft pointing jitter, the telescope had an effective resolution, in flight, better than 3". The six-channel spectrometer (H and K 3950 Å Ca II lines, h and k 2800 Å Mg II lines, H i La and Lß lines) is used with several entrance slits from 1" X 1" to 6" X 120" to give spatial resolutions and several exit slits to give spectral resolution from 0.02 Å to 1 Å. Details of the instrumentation and operation modes are given by Artzner et al. (1977).

For the observations presented here, the 6" X 120" entrance slit was used, and exit slits were chosen to give 0.02 Å and 0.06 Å spectral resolution in the La and Lß channels, respectively. The observational data were obtained at quiet Sun center on 1976 August 19 and at quiet Sun limb (15" inside the limb) on 1977 May 18.

III. DATA REDUCTION

a) Raw Data Reduction

From OSO 8 observations we know the variation of shape and intensity of La and Lß lines from disk center to disk limb. The average quiet Sun profile begins to change about 30" inside the limb. By using the limb profile we can weigh correctly the average center disk profile to obtain an average full disk quiet profile.

The raw integrated La profile given in Figure 1a represents such a combination of Sun center and limb profiles. Blue wavelengths are on the right and each grating step corresponds to 0.0083 Å. From this raw profile we have evidence of the very deep absorption profile given by the geocoronal La line.

To obtain the integrated Lß profile several steps of reduction are needed, due to overlapping orders. The LPSP spectrometer detects the Lß line in the 14th grating order, and, as there is no narrow band filter, the detector is illuminated by orders 15, 14, 13, 12, and 11; the cutoff is made by the combination of five reflectances on LiF 2 coating and the efficiency of the spiraltron detector. For each set of observations, taken either at Sun center or at Sun limb, average profiles are recorded first directly and then by using a MgF 2 filter.
(located on a filter wheel behind the entrance slit of the spectrometer) which gives the contribution of grating orders, 13, 12, and 11. The difference of profiles recorded without and with the filter, taking into account the MgF$_2$ transmission, yields a clean flux-equivalent profile which is shown in Figure 1b, where each grating step corresponds to 0.0074 Å.

b) Restoration of True Profiles

To filter the data we used a Fourier transform technique described in Brault and White (1971).

The restoration of the true profiles is made by deconvolution from instrumental broadening. Because no source with line width smaller than the expected instrumental profile was available in the laboratory, a ray-tracing computation was used to determine this instrumental profile and any ghost effects. The validity of the computation was checked by comparison with observed profiles in the magnesium and calcium channels where ghosts of the grating could also be measured. This permitted us to determine the amplitude of any defects in the grating. These defects were used to compute the position of ghosts for L$\alpha$ and L$\beta$.

By using an average geocoronal model for the orbital data, we computed geocoronal L$\alpha$ and L$\beta$ profiles; and comparing them with our observations, we confirmed our calculations of the instrumental profile (Bonnet et al. 1978).

IV. ABSOLUTE CALIBRATION

During the first year of operation in orbit of OSO 8, we launched two calibration spectrometers on the Laboratory for Atmospheric and Space Physics (LASP) rockets, number 21019 on 1975 July 28, and number 21030 on 1976 February 18. A 1/4 m Ebert-Fastie spectrometer was used to measure the absolute integrated flux over the solar disk. The detector (Bendix channeltron) was calibrated by reference to the secondary standard ultraviolet detector Bendix no. S/N 6027070. Techniques used for calibration of the secondary standard detector are described in Johnson (1969).

Only the second calibration flight yielded a good calibration. Table 1 summarizes recent measurements for L$\alpha$ and L$\beta$ lines and gives a comparison with this calibration.

Our L$\alpha$ flux is higher than other measurements but, within the error bars, we still are compatible. There are a few measurements of L$\beta$ and again, within the error bars, our determination is good. In § V the results of the 1976 February 18 LPSP calibration are used.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Range</th>
<th>L$\alpha$</th>
<th>L$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPSP (1976 Feb 18)*</td>
<td>70.1</td>
<td>5.46±30%</td>
<td>0.078±25%</td>
</tr>
<tr>
<td>LASP* (1976 Feb 18)*</td>
<td>70.1</td>
<td>4.05±20%</td>
<td>None</td>
</tr>
<tr>
<td>LSP* (1975 Jul 28)*</td>
<td>75.5</td>
<td>4.02±20%</td>
<td>None</td>
</tr>
<tr>
<td>OSO 5* (1975 Aug 8)</td>
<td>70.0</td>
<td>4.25±20%</td>
<td>None</td>
</tr>
<tr>
<td>AEC* (1976 Apr 6)†</td>
<td>71.0</td>
<td>None</td>
<td>0.031±40%</td>
</tr>
<tr>
<td>AFGL‡ (1976 Feb 20)*</td>
<td>70.0</td>
<td>None</td>
<td>0.073±30%</td>
</tr>
</tbody>
</table>

* Rocket.
† Satellite.

V. CALIBRATED PROFILES

From the absolute calibration and flux-equivalent profiles, we deduced the absolute flux of the Lα and Lβ profiles shown in Figures 2a and 2b.

The zero point of Lα wavelength is given by the central core of the geocoronal absorption Lα line. For Lβ we use the center of symmetry at half-maximum as the central wavelength. Since the profile is averaged over several profiles, this determination is accurate to within ±0.01 Å.

The Lα core flux is sensitive to the solar activity cycle, and, as pointed out by Vidal-Madjar (1975), a 50% change in total solar Lα flux produces an 80% change in the Lα core. The core of the line is also very sensitive to the features present on the quiet Sun (network, supergranular cell). The relatively small area (6° × 120°) covered by the entrance slit may have up to a 10% fluctuation in the core flux line.

The Lβ profile on Figure 2b is the first photoelectric record with high spectral resolution. This should yield a line shape with a higher confidence level than previous photographic records (especially in this wavelength domain where photographic calibration is difficult; Nicolas et al. 1976). The central core of the profile is affected by the geocoronal Lβ absorption line which is not resolved here, and from the Lα geocoronal line, we can estimate its contribution as between 10% and 20% (Bonnet et al. 1978).

From variations of the solar Lα flux with the solar activity cycle (Vidal-Madjar 1975), one may think that the Lβ flux should follow similar fluctuations. A recent paper from Heroux and Higgins (1977) does not confirm this extrapolation and, within the error bars of their five measurements, there is no apparent systematic variation of Lβ flux over an 8 year period. AE/C preliminary results (Hinteregger 1977) show fluctuations in Lβ flux, which does not seem to be correlated to 10.7 cm flux. From our OSO 8 experiment, we have evidence of variation of intensity from quiet to active Sun, and we plan in another paper to estimate this effect on the flux.

In conclusion, we have recorded center and limb H I solar Lα and Lβ profiles and, by using a calibration rocket flight, we have determined the absolute flux profiles.

We note that the central core of the Lβ line is in better agreement with the determination of the Hα geocoronal flux (Levasseur et al.) than previous determinations (Nicolas et al. 1976).

The OSO 8 LPSP experiment was operated from LASP, University of Colorado, and calibration rockets were a NASA cooperative program between LASP and LPSP. We want to thank LASP and LPSP staff members who were involved in these operations. This program was developed under CNES contracts 74 CNES 624-202, 75/76 CNES 202.

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