Abstract. Data on the spectrum and center-to-limb variation of the solar Lyman continuum have been analyzed. They show: (a) The brightness temperature of the Lyman continuum is about 6500 K, but the kinetic temperature, as deduced from the slope of the continuum, lies between 8000 and 9000 K. The difference between the kinetic temperature and the brightness temperature requires that the source function be smaller than the Planck function by a factor of several hundred. (b) The Lyman continuum exhibits slight limb darkening longward of 825 Å, and slight limb brightening shortward of 750 Å. The crossover point varies from equator to pole and with solar activity. (c) The slope \( \frac{d \ln I(\lambda)}{d \lambda} \) of the Lyman continuum decreases toward the limb, implying that the kinetic temperature increases outward in the region of Lyman continuum formation.

Using radiative transfer calculations for a plane-parallel atmosphere in hydrostatic equilibrium, we have derived a homogeneous model of the upper chromosphere that reproduces the main features of the observations. It is characterized by a temperature of 8300 K and a pressure of about 0.15 dyne/cm\(^2\) at \( \tau_{\lambda=1} = 1 \), and it has an abrupt temperature rise at a height of 1500 km above the limb. More precise agreement with the observations will require a detailed treatment of the inhomogeneous nature of the upper chromosphere.

1. Introduction

The first spatially resolved observations of the solar Lyman continuum were obtained during October and November 1967 with the Harvard College Observatory’s ultraviolet spectroheliometer aboard OSO-IV. These observations provide a great deal of information about the structure of the solar chromosphere in the region of formation of the Lyman continuum, which occurs at a height of about 1800 km above the photosphere.

In Section 2 of this paper we describe the new observations and their analysis, with special attention to the implications for the structure of the quiet chromosphere. In Section 3 we derive a model of the mean chromosphere that reproduces the main features of the observations and of related data in the visible and millimeter regions.

2. The Observations

The Harvard College Observatory’s spectroheliometer aboard the OSO-IV spacecraft has been described in detail elsewhere (Goldberg et al., 1968), and only a brief summary of its characteristics will be presented here. A collecting mirror with an aperture of 4 cm produced a solar image with a diameter of 4.7 mm at the entrance slit of an \( f/12.5 \) concave grating spectrometer. The square entrance aperture subtended an area of 1 arcmin square on the solar image. The exit slit had a band pass of 3.16 Å.
that was constant throughout the Lyman continuum region. There were two principal modes of operation of the experiment:

(a) *Spectral scan mode.* The grating could be moved continuously while the spectroheliometer, mounted on the pointed section of the spacecraft, was oriented to the center of the solar disk. In this mode the spectrum from 1400 to 300 Å was obtained for an area 1 arcmin square at the center of the disk. The time required for a spectral scan was 30 min. Since there was no solar activity at the disk center during the time of operation of the experiment, the spectra taken in this mode are representative of the quiet sun only.

(b) *Spatial scan mode.* The grating could be positioned at any wavelength in the range 1400 to 300 Å, to an accuracy of 0.5 Å, and the pointed section of the spacecraft could be commanded to make repeated raster scans so as to cover a 36-arcmin square region, centered on the solar disk, with a spatial resolution of about 1 arcmin. The time required to obtain each spectroheliogram was 5 min.

The spacecraft was commanded generally once per 90-min orbit. During each orbit about 60 min of daylight was available, so either about 2 spectra or about 12 spectroheliograms were obtained per command cycle.

During the 5 weeks of useful operation of the spectroheliometer, numerous spectra of the Lyman continuum were recorded at the center of the quiet sun. In addition, spectroheliograms were obtained at six different wavelengths in the Lyman continuum. We shall now discuss these two types of data in more detail.

A. SPECTRA AT THE CENTER OF THE SOLAR DISK

Figure 1 shows a typical spectrum of the center of the solar disk. The intensity is given in units of photomultiplier counts per 80-msec integration interval. The light, dashed line converts this scale to one of \( \text{photons/cm}^2/\text{sec/ster/3.16 Å} \), where the 3.16 Å interval represents the width of the spectrometer exit slit. (For individual emission lines, whose halfwidth is much less than the width of the exit slit the light dashed line converts counts to the total intensity integrated over the line in units of \( \text{photons/cm}^2/\text{sec/ster} \).)

We note from Figure 1 that the observed intensity departs considerably from that of a blackbody. The heavy dashed curve in the figure, which is the blackbody curve for a temperature of 6450 K, matches the observed intensity at the head of the Lyman continuum, but drops below the observed intensity by a factor of 2 at 825 Å, and a factor of 4 at 750 Å. However, below about 740 Å, there is no region that is clearly devoid of emission lines, so it is difficult to judge the true level of the continuum.

The slope \( \frac{d \ln I}{d \lambda} \) of the observed continuum could be matched approximately by a blackbody of considerably higher temperature, but then the absolute intensity would be much too high. For example, the solid curve in Figure 1, which is the prediction of the atmospheric model discussed in Section 3, coincides almost exactly with the curve for a blackbody with a temperature of 8300 K but whose intensity is decreased by a factor of 200. In Section 3 we shall conclude that the temperature in the region of Lyman-continuum formation actually is about 8300 K, and the dilution by a factor of