INTERPRETATION OF THE SOLAR CONTINUUM FROM 1680 TO 600 Å. MODEL OF THE TRANSITION REGION PHOTOSPHERE-CHROMOSPHERE AND OF THE CHROMOSPHERE

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Abstract. An interpretation is given of the observations of the continuous solar radiation in the spectral range 600-1700 Å. The model allows for deviations from LTE of H, C, Si and S, and is in hydrostatic equilibrium. The predicted intensity from 1680 to 1520 Å has virtually no dependence on the electron temperature variation in the optical depth range $10^{-3}-4 \times 10^{-6}$, at 5000 Å; the brightness temperature is compatible with a low electronic temperature minimum near the optical depth $10^{-4}$. The model of the low chromosphere is characterized by a steep temperature gradient. The model satisfies observations at millimeter wavelengths.

1. Introduction

During the last ten years advances in observational techniques have made it possible to obtain solar ultraviolet spectra. The first attempt to incorporate extensive data from the ultraviolet continuous spectrum into a solar model was made at the Bilderberg Conference in April, 1967. The Bilderberg Continuum Atmosphere (BCA) (Gingerich and de Jager, 1968) included a long temperature plateau of 4600 K between the photosphere and chromosphere. In the BCA model conflicting results from line-profile analysis - for instance the H and K line profiles which require a lower electron temperature minimum - were deliberately ignored. This discrepancy might be attributed either to a calibration error of the UV spectrum or to an error in the theoretical interpretation. At that time the only rocket results were those of Detwiller et al. (1961).

New observations of Parkinson and Reeves (1969) indicate a lower radiation temperature in the spectral range arising from the transition region: consequently a tentative revision of the BCA (called SA05) was proposed by Gingerich (1969) at the Pasadena meeting of the American Astronomical Society Solar Division.

With regard to the theoretical interpretation, the LTE assumption is not entirely valid. In the temperature minimum region between the photosphere and the chromosphere the effect of non-LTE is to underpopulate the neutral atoms such as H, Si (Cuny, 1968, 1969), so it may be possible to interpret the observations by a lower electron temperature. Furthermore it was obvious that it was necessary to take account of LTE departures to interpret the chromospheric spectrum below 1525 Å.

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In this work I have not attempted to determine the exact model of the Sun, but rather to learn what information is given about the solar model by the solar ultraviolet continuous radiation, and to evaluate between which limits this homogenous model changes when taking account of a possible error for instance on the calibration, or by improving the theoretical assumptions.

2. Observations

We quote only the observations which concern the solar continuous radiation from 1700 to 600 Å. The photographic observations of the Naval Research Laboratory (1959, 1961) have been analysed by Tousey (1963, 1964). New results have been published by Sandlin and Widing (1967) in the spectral range 1550−2100 Å. In 1967 at Harvard College Observatory, Goldberg et al. (1968) made measurements in the solar ultraviolet radiation short wavelength side of 1350 Å with a photoelectric spectrometer spectroheliograph on OSO IV. These observations are completed at longer wavelengths by those obtained from a rocket flight by Parkinson and Reeves (1969). The NRL and HCO observations are reported on Figure 1. On the various spectra I constructed a curve representing the continuous intensity, omitting as much as possible the Fraunhofer or emission lines. The points indicating the observations (Figure 1) were taken on this curve.

We recall first the results of the analysis of Tousey (1963, 1964) while comparing the various observations. There is generally a good agreement for the variation of the emergent intensity in terms of the wavelength, but except in the Lyman continuum and a very small range shortward of 1100 Å in the carbon continuum, the absolute intensity of the NRL observations is always larger than the HCO intensity.

As noted by Tousey, the spectral range 2000−1200 Å is of a particular interest because the emergent intensity arises from the transition region between the photo-

![Fig. 1. Predicted and observed intensities at the center of the solar disk (1700−600 Å). .... NRL observations, ++ HCO observations.](image-url)