SOLAR LINE BLOCKING FOR DISK-CENTER AND DISK-AVERAGED RADIATION FROM 3300 TO 6860 Å

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(Received 10 August, 1984)

Abstract. The line blocking is tabulated for 10 Å (λ < 6300 Å) or 20 Å (λ > 6300 Å) wide intervals. It follows from the spectral averages and the local continuum derived by Neckel and Labs from high-resolution Fourier transform spectra, which had been obtained by J. Brault at Kitt Peak. The internal accuracy (the scatter) is in the order of 0.1%. Significant systematic errors arising from local distortions of the adopted continuum level can be excluded. Larger errors are to be expected only near the Balmer limit, where the localization of the 'continuum' is very ambiguous.

1. Introduction

The fraction of the solar radiation, which is absorbed in the solar atmosphere by discrete absorption processes – the so-called line blanketing or line blocking – has been repeatedly tabulated by several authors; its importance for the theoretical treatment of the atmospheres of the Sun and of other late-type stars has been emphasized, e.g., by Ardeberg and Virdefors (1975).

A compilation of the line blocking for 100 Å intervals, which covers the spectral range from 3000 to 24700 Å, has been given by Wöhl (1975), but it includes only data, which deal either with the disk center or with sunspot regions. The disk-center data for λ < 7000 Å concern the line blocking derived by Wempe (1947) using the Utrecht atlas of Minnaert et al. (1940), and the line blocking resulting from the spectrophotometric atlases of Brückner (1960), Wöhl (1973), and Delbouille et al. (1973).

The atlas of Delbouille et al. (1973, 1976) was used also by Ardeberg and Virdeors (1975, 1978) to derive the line blocking between 4010 and 6860 Å for 10 Å intervals. For the flux- (irradiance-) spectrum detailed line blocking data have not yet been published.

The new line blocking data, which are given in this paper for the spectral range from 3300 to 6860 Å, concern not only the spectrum of the disk center, but also that of the full disk. These data have been obtained from high-resolution Fourier transform spectra, which are practically free from local distortions of the intensity scale. Therefore, local systematic errors, which occur in all formerly published line blocking data at spectral regions with poor definition of the continuum, are minimized as far as possible. Further-

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more, the use of the same optical equipment, the nearly identical observing technics, and the common treatment of the observational data do allow a very precise, differential comparison between disk-center and full-disk line blocking. By this way one obtains for all parts of the spectrum valuable information about the average center-to-limb variation of the absorption lines. Finally, for the use as reference data in stellar spectrophotometric work the full-disk data are — of course — the only relevant ones.

2. Solar Line Blocking Data for Disk Center and Full Disk

The new line blocking data follow directly from (a) the spectral averages for 10 Å (or 20 Å) wide passbands and (b) the polygonal tracks of the radiation temperatures representing the ‘local continuum’, which have been published by Neckel and Labs (1984). Therefore, this contribution should be considered as a supplement to the quoted paper, and with respect to any details of the basic data treatment we refer to that reference. Here we summarize only those facts, which are the most relevant ones for the derivation and the correct use of the line blocking data:

(1) The spectral averages as well as the ‘continuum’ data for the disk-center intensity and the irradiance as well were deduced from the high-resolution Fourier transform spectra (FTS), which were recorded by J. Brault at Kitt Peak (so far unpublished; but see J. Brault, 1979) and were absolutely calibrated by Neckel and Labs (1984).

(2) In the spectral averages, reliable elimination of the telluric line absorption was possible only for \( \lambda < 6860 \) Å. Above that wavelength the spectral averages were obtained from the FTS continua and the equivalent widths of the solar absorption lines. Therefore new, precise line blocking data can be given only for the spectral range from 3300 to 6860 Å.

(3) The course of the solar ‘continua’ was obtained by extracting from the calibrated FTS spectra the maximum intensities in 5, 10, or 20 Å wide intervals and approximating the ‘upper envelopes’ of the corresponding radiation temperatures by polygonal tracks.

(4) The internal, relative errors of the spectral averages are in the order of 0.1%.

(5) Concerning the localization of the continuum one should keep in mind, that it “is well defined down to 4420 Å, and may even be quite reasonably established down to 4020 Å. But below that limit, especially in the vicinity of the Balmer limit, its localization is — at least from the observer’s point of view — necessarily subject to personal arbitrariness”. Therefore, for wavelengths below 4020 Å our line blocking data should be taken merely as lower limits rather than as ‘true’ values. Special attention should be called to the wavelength difference between the theoretical Balmer ‘jump’ and the actual jump in the observable ‘local continuum’, which occurs between 3770 and 3780 Å, near the position of the Balmer line \( \text{H}_1 \) (3770.63 Å)! Nevertheless, as the ‘local continuum’, to which the line blocking has been related, is well defined, it is no problem to adapt the data to any other continuum level preferred. Furthermore, as the definition of the ‘local continuum’ is almost identical in both spectra (for disk center and full disk), the differences ‘disk minus center’ will be nearly correct.

The line blocking data \( n_{\text{center}} \) and \( n_{\text{disk}} \) for disk center and full disk respectively, which