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LONG-TERM VARIATIONS OF SOLAR SPECTRAL LINES

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Abstract. The main objective of this paper is to outline the results on the observations and theoretical interpretations of the long-term variations of solar spectral lines. The discussion is limited to the absorption spectral lines in the visible region of solar spectra.

The observations in the visible region of solar spectra show a variability of spectral lines that lasting for years and decades (long-term variations). This paper will present investigation results of long-term variations of spectral lines.

Kharadse (1935), Derviz et al. (1961), Mitchell (1969) and Zhukova and Mitrofanova (1973) found activity-dependent changes of the widths (W), the central depth (CD), equivalent widths (EW) of some spectral lines in different periods. However, covering a part of these time intervals Krat et al. (1975) did not corroborate these results. Stepanyan and Shcherbakova (1979) extracted 63 spectral lines, out of 1000 observed, showing considerable changes of their CDs, Ws and EWs. Livingston and Holweger (1982) found a secular decrease of equivalent widths with time from the period 1976-1980. On the basis of observations from 1969 till 1979 Kokhan (1987) found that the CD, W and EW change in dependence on the solar activity. Livingston and Wallace (1987) for selected spectral lines observed during the period 1976-1985 found that the EW of the MnI 539.47 nm line shows the greatest variability. Livingston (1992) found that strong metallic lines have little or no cycle variations, while the intermediate strong metallic lines vary about 1%. The CI 538.03 nm line shows a monotonic increase in equivalent width from 1979 to 1992. Babij (1991) found that the scattering of observed central depth of moderately strong spectral lines decrease with an increase of excitation potential, while for weak lines such a dependence is absent. Theoretical works and model calculations of the heat transfer process from the solar interior show that The magnetic field depresses convection that cause change of asymmetry of spectral line profiles (Livingston 1982). Brandt and Solanki (1990) and Immerschitt and Schröter (1989) found that the D decrease, while the W increase with increasing magnetic filling factor. The EW of some lines (mostly strong or temperature insensitive lines) remains unchanged, while decreases for other (weak lines). A similar conclusion has been derived by Cavallini et al. (1986). Besides, the authors pointed out the increasing of the width of both the 630.15 nm and the 630.25 nm spectral lines, especially near the continuum level. This result is in accordance with activity cycle dependence of the line equivalent widths found by Livingston and Holweger (1982).

Calculating the influence of convective motion on the spectral line profiles, Dravins et al. (1981) concluded that the main cause of their asymmetry is a specific distribution of plasma velocities and temperature within the convective cells. A part of the asymmetry in some spectral lines may be caused by interatomic collisions of absorbers and perturbing particles (Vince and Dimitrijević, 1986).

A long-term program of full solar disk observations was initiated in 1986 . Routine observations of 31 photospheric spectral lines at Belgrade Astronomical Observatory are in progress since 1987. Significant changes of equivalent width have been found in 8 spectral lines, out of 18, during the years 1987–1992 (Skuljan et al. (1993)). All these equivalent widths reach their maximum values near the time of solar activity maximum. The other Fraunhofer lines do not change its equivalent widths or the changes are not reliably measured now. Theoretical study of these observed spectral lines show significant changes of the EW, W and D of some of these lines as functions of temperature gradient, but negligible dependence of these parameters on variations of the photospheric pressure gradient (Erkapić and Vince (1993a, 1993b)).

On the basis of this briefly rewied results of various authors it has been seen that the central intensity, half-width, equivalent width and asymmetry of Fraunhofer lines change in dependence on the solar activity. The results of various authors are very different and some of them are even contradictory (e.g., Zhukova and Mitrofanova (1973), and Krat et al. (1975)). Since the question of coorelation of spectral line parameters with solar activity has not been finally solved, further studies of varibility of Fraunhofer lines can be taken as scientifically interesting.

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