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8. HYDROGEN AND HELIUM EXCITATION IN THE CHROMOSPHERE AND CHROMOSPHERIC FLARES

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Spectroscopic investigations show that the nature of the excitation of hydrogen and helium atoms in flares is different in different flares. For instance, the appearance of helium lines (more frequently in absorption) is not necessarily accompanied even by comparatively bright flares of importance 2. Observations made at Pulkovo during 1956–8 show that the absorption in D_3 usually does not appear in the region of maximal Hα-brightness. In this respect observations of spectra of limb flares are of special interest. On 1958 April 23 we obtained spectra of a limb flare in a comparatively wide spectral region, which showed the lines He 4472 and 4713 in emission. We were not able to detect any traces of He^+ 4686 (Zirin [1]). This can be explained if we assume that the hydrogen lines and those of neutral and ionized helium appear under different physical conditions in different parts of the flare.

V. Krat and L. Pravduke [2] and [3] found that the chromosphere may be considered as consisting of a number of short-lived filaments with temperatures and densities varying within wide limits. We also assume that the chromospheric flares are composed of different filaments or layers with different temperatures and densities. Our observations do not show any evidence of a line broadening of the Balmer series from Hδ to H_{10} and H_{11} due to the Stark effect. There is also no noticeable self-reversal in these lines. However the hydrogen line profiles show that above the flare there is matter causing light scattering. This matter gives rise to absorption line profiles which are narrower than those of the emission lines of the flare and not broader than the ordinary chromospheric lines. Also the ejections from the flare, predominantly directed towards the photosphere, are observed in emission in the lines of hydrogen and ionized calcium H and K [4]. Investigation of the problem of helium equilibrium in flares, taking into account the photo-ionization from the level 2^3S and the impacts of the second type for the level 2^3S and other factors, permitted us to calculate the number of He atoms in various states and to evaluate the ionization of He. As the transitions between the higher levels, for low electron concentration n_e, are due mainly to photospheric radiation, the ratios of the line intensities $4472/D_3$, $4713/D_3$, $3889/D_3$ are practically constant for all T_e, being equal to: $4472/D_3 = 0{\cdot}10$; $4713/D_3 = 0{\cdot}01$; $3889/D_3 = 0{\cdot}09$.

The normal ratio of the intensities of the lines He 5876, 4472, 4713, 3889 in flares can change only for high electron concentrations, not less than 10^{13}. This points to an extremely high density of the 'helium' filaments of the flare observed by Zirin [1]. In the majority of flares the density of these filaments must be lower. This in general does not contradict the results of E. Mustel and A. Severny [5]. The exceptionally rare appearance of the line He^+ λ4686 in prominences and flares shows that it cannot be caused either by coronal radiation or by the ultra-violet radiation of the 'helium' filaments themselves. It appears only in subcoronal filaments, which can be formed during the transformation of chromospheric matter into coronal gas or vice versa.

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