much higher temperature than $0.8 \cdot 10^6$°K in order to be able to observe λ 4086. Therefore as I. S. Shklovsky[12] already pointed out, we might have to introduce an inhomogeneous corona with hot and cold elements both in the normal corona and in the condensation.

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Discussion

Biermann, L.: The problem of the several sources of information on the coronal temperature was rediscussed in a contribution to the I.A.U. corona symposium of last week by Lüst, Schmidt, Trefftz and myself. In so far the equivalent width gives eventually the temperature derived from the ionization equilibrium. This should lead to (relatively) the most trustworthy temperature value; but the whole subject is still to some extent controversial.

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II-3A-10. Structure of the Flare

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The line widths of Balmer series lines from H_α to H_{14} were measured on a number of spectrograms of disk flares and limb flares of medium importance taken by a wide range spectrograph with the dispersion of 3A/mm. From these widths we derived the values of the electron density and the total number of hydrogen atoms along the line of sight in the second quantum state. On the basis of uniform model of the flare, these two values can only be made compatible when the very small geometrical thickness of the order of 10 km is attributed to the whole extension of the disk flare and the limb flare. We like to suggest, therefore, that the flare is composed of unresolvably fine, presumably thread like, condensations distributed over the whole extension. Further since the limb flares show essentially the same structure as the disk flares, we are inclined to believe that the origin of the flare must lie somewhere in the corona or in the higher chromosphere. Moreover we suspect that all the disk flares might be limb flares seen projected on the disk.

Balmer series lines and metallic lines were measured on spectrograms taken with a wide range spectrograph which permits a simultaneous exposure of the wavelength range from $H\alpha$ to the Balmer continuum. Dispersion was about 3A/mm. Among one hundred spectrograms, 4 disk flares of importance 2^+ and 1^+, and two limb flares were selected for analysis[1),2)].

Profiles of disk flares were corrected for

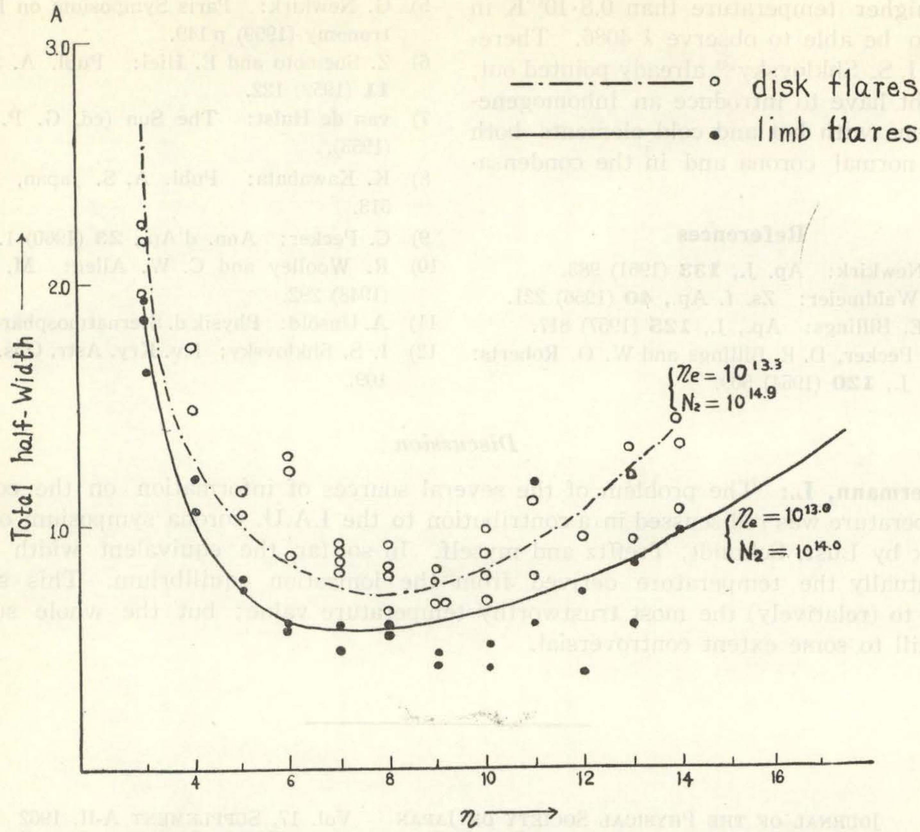

Fig. 1. Total half width of Balmer lines plotted against principal quantum numbers n.

the background absorption spectrum based on the simple theory of emission line formation.[1] In Fig. 1 total half widths of these corrected profiles were plotted against principal quantum numbers n of the upper state of the lines. The large widths of the lower members were interpreted as the effect of self-absorption and the increase to the higher members was assumed to be due to Stark broadening. We assume the Doppler width to be equal to the temperature 15,000°, which was derived earlier by Z. Suemoto[3] from the relative intensities of emission lines of the flare. We also assume here the constant source function in the line of sight. After a number of trials we found the best fit can be obtained for

$$N_2 \sim 10^{14.9}\,\mathrm{cm}^{-2}\,,$$

and

$$n_e \sim 10^{13.3}\,\mathrm{cm}^{-3}\,.$$

N_2 is the number of hydrogen atoms in the 2nd quantum state contained in a column of unit cross section along the line of sight. n_e is the number of electrons in unit volume.

From this electron density we can derive the number density of hydrogen atoms e.g., in the eighth quantum state, n_8, using Boltzmann-Saha's equation. As the energy difference between the eighth quantum state and the continuum is very small, derived value of n_8 is not sensitive to the adopted temperatures. We get, thus, $n_8 \sim 10^{7.6}$.

On the other hand from the number of hydrogen atoms in the line of sight, N_2, we can estimate the corresponding number, N_8, in the eighth quantum state, using Boltzmann equation. We assume that the excitation temperature governing the 2–8 transition is very close to the temperature inferred from the central intensity of $H\alpha$. Adopting the excitation temperature $\sim$5600° and $N_2 \sim 10^{14.9}$, we obtain $N_8 \sim 10^{13.3}$. Comparing N_8 with n_8, we get the effective thickness or true thickness of the flare

$$\text{Flare thickness} \sim \frac{N_8}{n_8} \sim 10\,\mathrm{km}\,.$$

This thickness is about a factor of 100 smaller than the scale height of the chromosphere, 1000 km.

Same kind of analysis was applied to the limb flares[2]. As the spectrum of the limb flare is purely an emission spectrum, the analysis is more straight-forward. Again in Fig. 1 we plotted the total width of Balmer lines of limb falres. The theoretical curve was obtained using a thermal width which was, this time however, inferred from the width of metallic lines, *i.e.*, TiII, CaII and SrII. The result is as follows:

$$N_2 \sim 10^{14.0}\,\mathrm{cm}^{-2}$$
$$n_e \sim 10^{13.0}\,\mathrm{cm}^{-3}.$$

It is to be noted here that these two parameters are also consistent with the change of central intensities of the Balmer series lines with the principal quantum numbers, *n*. The effective thickness of the emitting region turned out to be again about 10 km, which is to be compared with the estimated extension of 20,000 km of the limb flares studied. This is confirmed also by the analysis of metallic lines.

Now it looks to be established that emission of both disk flares and limb flares are

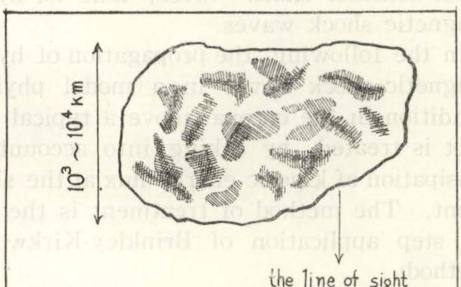

Fig. 2. Schematic illustration of the filamentary structure of the flare. The sum of the thickness of the small filaments in the line of sight is no more than 10 km.

confined to an unconceivably thin layer[4]. We should like to propose, therefore, that the flares consist of a great many of, presumably, filamentary condensations. Fig. 2 shows a schematic illustration of the flare. Here we note that we do not use the words "filament" or "condensation" as indicating such structures that can be observed with spectrohelioscopes or spectroheliographs. We regard them as the observationally unresolvable small scale structures.

More detailed discussions of the flare and the limb flare will be found in the references[1),2)].

Since the limb flares have essentially the same structures as the disk flares, we are inclined to believe that the disk flare may occur somewhere in the corona[5], and we suspect that substantial fraction of the number of disk flares might actually be limb flares seen projected on the disk. If it is admitted, the flare should probably be interpreted as cold condensations in the hot corona or in the high chromosphere. Thus the theory of the flare must explain the cooling mechanism[6] (perhaps due to radiation) and the mechanism of the violent condensation into many small filaments.

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Discussion

Biermann, L.: The high level of the flare appears to introduce a certain difficulty with respect to the electron pressure obtained, which would perhaps deserve some further discussion.

Takakura, T.: The pressure might be balanced by the magnetic field.

Hiei, E.: It is indeed if the magnetic field is excluded.

Athay, R.G.: Is the model of the flare very thin sheets or small balls?

Hiei: As far as the spectroscopic evidence is concerned it may be any shape.