measuring a in photoemulsions placed in various magnetic fields.

An analogous result, a ≈ 1/3 was obtained by Vaĭsenberg et al. and Lynch et al.[2,8] for emulsions placed in strong magnetic fields.

In conclusions, the authors express their gratitude to B. S. Neganov and B. V. Sokolov for aid in the irradiation of the photoemulsions, to D. M. Samoĭlovich for developing the emulsion, and also to V. M. Kutukova, A. M. Alpers, and G. V. Pleshivtseva for help with the work.

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BROADENING OF SPECTRAL LINES IN STRONGLY IONIZED PLASMA

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MEASUREMENTS of the width of spectral lines are often used to determine the density of charged particles in a plasma; at the same time, the investigation of line broadening in a plasma is by itself an interesting physical problem, since under plasma conditions the emitting atoms are subjected to extremely strong rapidly-changing inhomogeneous fields of the surrounding particles, fields which cannot be achieved by other means. Until recently, only the line widths were usually studied; considerably greater information can be obtained if the line widths are measured simultaneously with the line shifts.

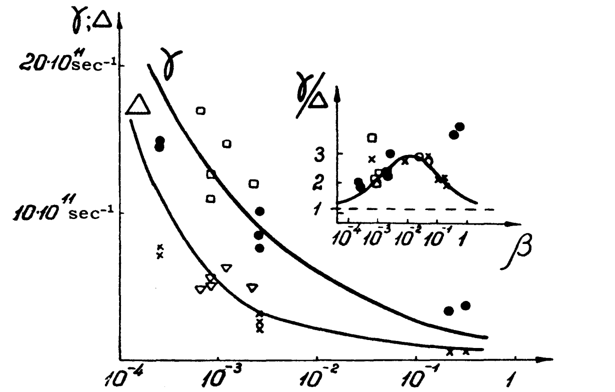
The results of our preliminary measurements of line widths and shifts in the plasma of a spark discharge[1] show a drastic qualitative disagreement with the existing Weisskopf-Lindholm theory, according to which the ratio of width to shift must have for all lines a constant value 1.6 and must depend on Stark's constant C_4 as $C_4^{2/3}$ (C_4 determines the line shift in a constant electric field, $\Delta\nu = F^2C_4/e^2$, where e is the charge of the electron, $\Delta\nu$ is expressed in cm^{-1}, and F is in electrostatic cgs units). On the basis of these measurements, a new non-stationary theory of line broadening due to charged particles has been developed by Vaĭnshteĭn and Sobel'man,[2] according to which the broadening and shift substantially depend on the parameter $\beta = (Z\mu/m)(\Delta E/kT) \times (S/3ga_0^2)^{1/2}$. Here Z is the charge, μ is the mass of the perturbing particle, m is the mass of the electron, ΔE is the separation between the level under consideration E_1 and the nearest excited level E_2 (only one excited level is assumed to exist), and S is the oscillator strength of the line corresponding to the transition between the levels E_1 and E_2. The ratio of the width to the shift also depends on β and is not the same for all lines.

We have measured, with a considerably improved accuracy the widths and shifts of 50 lines of A II and several lines of He I in the plasma of the spark discharge in argon and helium (U = 14 kv, C = 0.02 μf, L = 10 μh) at temperatures of $3 \times 10^4 - 4 \times 10^4$ °K and an electron density of $\sim 10^{17}$ cm^{-3}. Spectra were photographed by means of a spectrograph with a dispersion of 2 A/mm. The line widths γ were measured in the usual manner, the line shifts Δ in the spectrum of the spark were measured relative to the same lines in the discharge spectrum of a hollow cathode, where the lines could be considered unshifted. The accuracy of the width measurements was 5 to 10%, the smallest definitely detectable shift was ≈ 0.03 A.

The results of measurements have confirmed the preliminary conclusions. In the accompanying table we give data for 6 lines of A II; they are typical for the rest of the lines measured. The constants C_4 are calculated from the measurements of Minnhagen[3] and Maissel[4] in a homogeneous field. The ratio γ/Δ varies from 2 to

λ, A	$10^{-11}\,\gamma$, sec^{-1}	$10^{-11}\,\Delta$, sec^{-1}	γ/Δ	$10^4\,C_4$, cm^4·sec^{-1}	ΔE, cm^{-1}	β
4579.4	5.1	0.45	11.5	0.5	10000	0.31
4460.4	3.8	0.66	5.8	0.5	8000	0.22
4598.8	8.4	2.7	3.1	7.8	122	$2.6\cdot10^{-3}$
3561.0*	12	5.0	2.4	9.2	100	$2.2\cdot10^{-3}$
3559.5*	13	5.6	2.3	2.0	40.5	$8.5\cdot10^{-4}$
4474.8	15	7.8	1.9	5.5	13.5	$2.6\cdot10^{-4}$

*ΔE has been calculated for these lines.



Dependence of the width γ and the shift Δ on β. The curves give theoretical results; • and x are experimental γ and Δ for the lines with known ΔE; □ and ∇ are experimental γ and Δ for the lines with calculated ΔE. The insert gives the dependence of the ratio γ/Δ on β. The dashed line represents the results of the stationary theory; the solid curve represents the results of the non-stationary theory; • and □ are for the lines of A II; o are authors' measurements for the lines of He I; x are for the lines of He I after Wulff.[5]

10, and the width changes only by a factor of 3 or 4 when C_4 changes by two orders of magnitude.

The accompanying figure gives a comparison of experimental results with the results of the non-stationary theory. In our case the data necessary for the calculation of β (ΔE and S) are available for only 7 lines. For the remaining lines, in view of the incomplete term level diagram of A II, the values for ΔE are unknown. We have estimated these quantities by using the data on the shift in a homogeneous field,[4] assuming that the oscillator strengths are approximately the same for all lines. In the upper picture (dependence of γ/Δ on β) we have also plotted Wulff's[5] data for He I lines, for which we have calculated the β values (ΔE and S are known).

As can be seen from the figure, the agreement of the experiment with the non-stationary theory is quite good. It should, however, be noted that for several lines the experimental values $\gamma/\Delta \approx 10$ considerably exceed the theoretical values; in a number of cases this can be apparently explained by the existence of two or more excited levels.

By way of a practical conclusion it may be mentioned that it is advantageous to use line shifts for determining the electron density, since additional data on second-order collision cross sections are required for the calculations from the widths. Corresponding measurements for the plasma which we have investigated gave $n_e \approx 1.5 \times 10^{17}$ cm^{-3} for argon and $n_e \approx 7 \times 10^{16}$ cm^{-3} for helium in good agreement with the estimates obtained on the basis of line intensities of A II and A III with the aid of Saha's formula.

In concluding, we should like to remark that previously we used $\gamma/\Delta = 1.6$ for the lines of Ca I in the plasma of an arc.[6] For the investigated lines the non-stationary theory gives only minor corrections, and the conclusions of this investigation remain valid.

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