the wave packet as well as the amplitude, but the separated beams continue to have similar space-time structures. Therefore when both windows are open the number of coincidence increases compared with the random coincidences (or else compared with the number of coincidences due to the Bose statistics). We are unable to stop to consider the general problems of optic coherence and photon statistics. The modern status of the problem is presented in considerable detail in the lectures of Glauber [2] and in the review of Wolf and Mandel [3].

[1] R. N. Kuz'min, A. V. Kolpakov, and C. S. Zhdanov, Kristallografiya 11, 511 (1966) [Sov. Phys.-Crystallogr. 11, 457 (1967)].

[2] R. J. Glauber, Optical Coherence and Photon Statistics, in: Kvantovaya optika i kvantovaya radiofizika (Quantum Optics and Quantum Radiophysics), M., 1966 [Probably: Phys. Rev. 130, 2529 (1963)].

[3] E. Wolf and L. Mandel, Revs. Modern Phys. 37, 231 (1965).

* The maximum of the distribution (5) occurs at $\bar{N}_{12} = \bar{N}_1^0 + \bar{N}_2^0 + \bar{N}_b$. According to measurements, $\bar{N}_1^0 = 257$, $\bar{N}_2^0 = 331$, and $\bar{N}_b^0 = 729$, and therefore $\bar{N}_{12} = 1317$.

"ISOMAGNETIC JUMP" IN THE FRONT OF A STRONG COLLISION-FREE SHOCK WAVE

R. Kh. Kurtmullaev, V. L. Masalov, K. I. Mekler, and V. I. Pil'skii
Institute of Nuclear Physics, Siberian Division, USSR Academy of Sciences
Submitted 24 November 1967
ZhETF Pis'ma 7, No. 2, 65-70 (30 January 1968)

Investigations of collisionless shock waves with the aid of magnetic probes have revealed a change in the front structure and an increase in its width Δ when the critical Mach number $M_{cr} \simeq 3$ is reached [1]. The values of Δ and M_{cr} do not contradict the theoretical notions concerning the toppling of a strong shock wave [2]. From the theory and from the results of simulation by means of an electric computer [3] it follows that the toppling of the wave is preceded by a unique effect, namely an increase in the relative slope of the jump in the plasma density n. In addition, the subsequent violation of the single-stream character of the flow should alter the initial distribution of the physical parameters in the front (when $M < M_{cr}$).

We present in this paper the results of an investigation of the distribution of the density and magnetic field H on going through the critical value of the Mach number.

The experiments were performed with the UN-4 setup [4]. The plasma ($n_0 \sim 10^{13} - 10^{14}$ cm^{-3}) was produced in a cylindrical volume of 16 cm [sic!] placed in a quasistationary magnetic field (H_0 = 100 - 1000 Oe) and was subjected to compression by a rapidly growing field ($H_\sim^0$ = 2 - 3 kOe). The resultant cylindrical shock wave propagated towards the axis. The profile of the magnetic field in the wave was registered with a magnetic probe (single loop of 2 - 3 mm diameter; Fig. 1). The microwave probing (λ = 2 mm) was carried out in the plane of the wave front with the aid of miniature dielectric antennas of 1.5 mm diameter, spaced $l \sim 3\lambda$ apart. The system ensured spatial resolution within the shock discontinuity ($\Delta \sim 1 - 4$ cm). The magnetic probe and the microwave antennas were placed at the same distance from the axis ($r \simeq R/2$) and were shifted 30° in azimuth.

In order to trace qualitatively the realignment of the front structure, the measurements were performed initially by using a "cutoff" scheme [5]. The detector registered the microwave

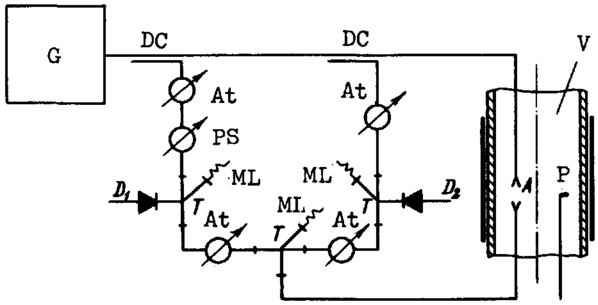

Fig. 1. Diagram of microwave and magnetic probing. V - plasma volume, P - magnetic probe, A - microwave antennas with dielectric radiators, G - microwave generator, DC - directional coupler, At - attenuator, PS - phase shifter, D - detector, T - twin tee, ML - matched load.

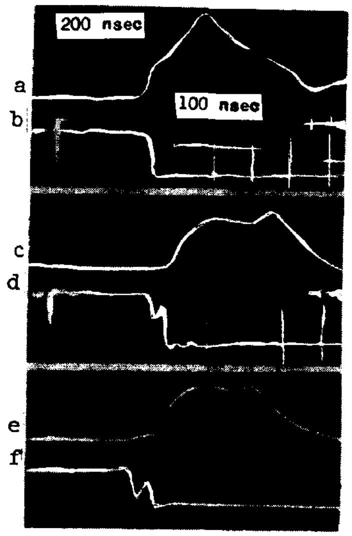

Fig. 2. Influence of Mach number on the structure of the wave front: a,c,e) magnetic-probe signals; b,d,f) signals from microwave detector; a,b) M = 2; c,d) M ≃ 3.2; e,f) M ≃ 3.5.

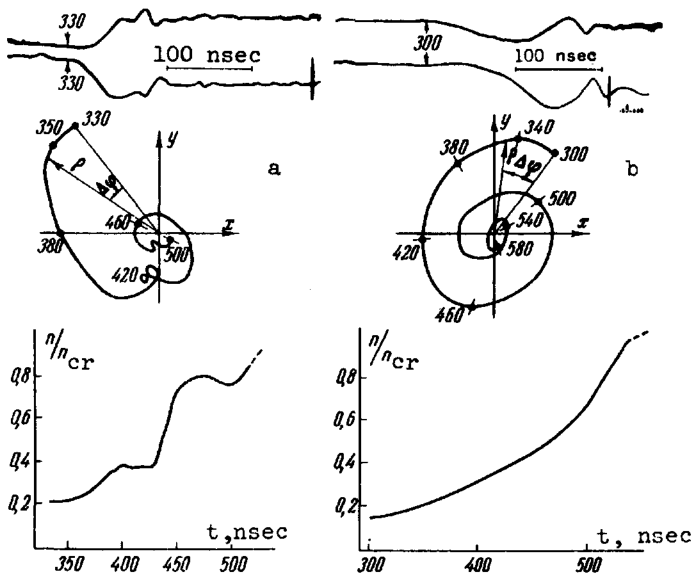

Fig. 3. Voltages across the interferometers, hodographs, and the profiles constructed from them for the density of the wave front: a) M ≃ 3.2; b) M ≃ 4.5; t = 0 is the instant when the magnetic piston is turned on.

power attenuation due both to damping and to "cutoff" of the signal near the critical density ($n_{cr} \simeq 2.1 \times 10^{14}$ cm^{-3}). Figure 2 shows a sequence of transition stages of the front realignment with increasing Mach number M. When $M < M_{cr}$ the magnetic probe registers a periodic wave front (Fig. 2a, $M \sim 2$), the measured width of which is $\Delta \sim 10c/\omega_0$ (c - speed of light, ω_0 - electron plasma frequency). The signal from the microwave detector always increases monotonically in this mode, and is similar to the magnetic profile of the front. When the critical wave amplitude is reached ($M \tilde{>} 3$), the signal from the detector changes qualitatively (Figs. 2d, f). A plasma layer is detached from the main discontinuity in the front, and broadens continuously with increasing Mach number. At the same time, the magnetic probe records the appearance of a "pedestal" - a region with weak variation of H (Figs. 2c, e). The abrupt decrease in the growth rate of the magnetic field in this region points to the appearance of a mechanism different from the turbulent conductivity that determines the wave profile when $M < M_{cr}$.

A quantitative measurement of the distribution of the plasma density and conductivity in the wave front was made with the aid of a high-speed microwave interferometer [4]. The circuit (Fig. 2) has two reference arms, the electric lengths of which differ by $\lambda/4$. This makes it possible to construct from the voltages $U_1(t)$ and $U_2(t)$ on the detectors D_1 and D_2 a hodograph of the quantity $[U_1(t)^2 + U_2(t)^2]^{1/2} \exp\, [i\Delta\varphi(t)]$ (Fig. 3). The density n(t) and the hf conductivity σ of the hf plasma are determined directly from the changes of the angle $\Delta\varphi(t)$ and the radius vector $\rho(t)$

$$\Delta\phi(t) = \frac{2\pi\ell}{\lambda}\left(1 - \sqrt{1 - \frac{n(t)}{n_{cr}}}\right); \quad \rho(t) = \sqrt{\frac{U_1^2(t) + U_2^2(t)}{U_0^2}} =$$

$$= \exp\left(-\frac{4\pi l \sigma_{hf}}{c\sqrt{\epsilon}}\right)$$

(U_0 is the value of $(U_1^2 + U_2^2)^{1/2}$ in the absence of damping, and $\epsilon = 1 - n/n_{cr}$ is the dielectric constant of the plasma.

The use of broadband apparatus ($\Delta f \sim 150$ MHz, $(d\varphi/dt)_{max} \sim 3 \times 10^8$ rad/sec) has made it possible to register density discontinuities $\Delta n \sim 10^{14}$ cm^{-3} in a time $\Delta t \sim 10$ nsec ($(dn/dt)_{max} \sim 10^{22}$ cm^3/sec).

Experiments performed in a wide range of the parameters (n_0, H_0, $H_\sim^0$) have shown that the detector signals, which have in the case of an aperiodic front (when $M < M_{cr}$) the form of damped sinusoids (corresponding to a monotonic growth of the density), are radically altered when the critical Mach number is reached, and acquire the character of irregular curves. Figure 3a illustrates the probe measurements of the density under conditions corresponding to Figs. 1c, d ($M \tilde{>} 3$). A distinguishing feature of the obtained n(t) distribution, which is typical of the "critical" regime in general, is its highly ragged character. The width of the jump is smaller than the width of the aperiodic section of the magnetic profile of the front, in agreement with the results of simulation of the problem at $M \gtrsim M_{cr}$ [3]. Such a front structure is similar to the known "isomagnetic jump" of magnetohydrodynamics for waves under conditions of low conductivity [6], where the temperature and the velocity experience a jump, whereas the front of the magnetic field is "smeared out." Using the concept of the toppling of the wave we can explain also the formation of an "advance" layer of perturbed plasma ahead of the jump, as a result of the "spilling over" of the front at $M \gtrsim M_{cr}$, when the turbulent dissipation is insufficient to compensate the nonlinear twisting [2]. Violation of the single-stream nature of the ion motion and the appearance of a viscous mechanism should change the rate of growth of H, as is indeed observed in the experiment. When the Mach number is increased ($M \sim 4 - 5$) the region of the "pedestal" broadens, and the region of the abrupt jump disappears. The resultant relatively smooth n(t) profile (Fig. 3b) apparently corresponds to a "steady" state of the front after its toppling. It is typical that in this case the rate of growth of the magnetic field assumes over the entire front ($\Delta \rightarrow Mc/\Omega_0$, where Ω_0 is the ion plasma frequency) approximately the same value as it had in the "pedestal" region.

The measurements of the plasma conductivity and the investigation of the laws governing the electric and magnetic fluctuations in the wave front agree with the foregoing picture of the realignment of the front structure.

The authors are sincerely grateful to R. Z. Sagdeev and Yu. E. Nesterikhin for discussions, and to V. G. Eselevich, Yu. M. Malyavin, and Yu. L. Koz'minykh for help with the work.

[1] R. Kh. Kurtmullaev, Yu. E. Nesterikhin, V. I. Pil'skii, and R. Z. Sagdeev, Paper 21/218 at 1965 Culham Conference; Conference Proceedings VII, 367; I. M. Paul, L. S. Holmes, M. I. Parkinson, and I. Sheffield, Report at Int. Conf. on Phenomena in Ionized Gases, Belgrade, August, 1965.

[2] R. Z. Sagdeev, Voprosy teorii plazmy (Problems in Plasma Theory), Vol. 4, p. 20, Atomizdat, 1964.

[3] Yu. A. Berezin and R. Kh. Kurtmullaev, Fizika goreniya i vzryva (Physics of Combustion and Explosion), 3, 3 (1966).

[4] R. Kh. Kurtmullaev, Dissertation, Novosibirsk, 1965.

[5] V. D. Rusanov, Sovremennye metody issledovaniya plazmy (Modern Methods of Plasma Research), Gosatomizdat, 1962, p. 41.

[6] W. Marshall, Proc. Roy. Soc. 233A, 367 (1955).

TWO-PHOTON DECAY OF 2s LEVEL OF HYDROGEN

B. A. Zon and L. P. Rapoport
Voronezh State University
Submitted 14 October 1967
ZhETF Pis'ma 7, No. 2, 70-72 (30 January 1968)

As is well known, the decay of the metastable 2s state of a hydrogenlike atom proceeds essentially as a result of emission of two photons, with the atom going over into the 1s state. Much progress was made recently in the experimental study of this phenomenon [1]. The spectrum and the lifetime of the transition are calculated theoretically by numerical summation of series, and therefore only several points of the spectrum are known [2]. The purpose of the present note is to present a complete analytic solution of this problem by using an explicit expression for the Green's function of the electron in the Coulomb field in the coordinate