EXPERIMENTAL INVESTIGATIONS OF ONE POSSIBILITY OF BLOOMING THE INHOMOGENEOUS PLASMA.
2. PECULIARITIES OF REALIZATION OF PLASMA BARRIER TRANSILLUMINATION FOR ELECTRON WAVES IN A LOW-MAGNETIZED PLASMA

D.B. PALETS, L.I. ROMANYUK

Institute for Nuclear Research, Nat. Acad. Sci. of Ukraine
(47, Nauky Prosp., Kyiv 03028, Ukraine)

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Peculiarities of a realization of the transillumination of the plasma barrier for upper hybrid electron waves in a low-magnetized plasma due to the mechanism based both on the kinetics of plasma electrons trapped in the potential well of a plasma formation and on their phase focusing are studied. The analysis of these peculiarities is used to forecast the dependence of the transillumination efficiency on the wave frequency and on plasma system parameters. The qualitative agreement of the forecasted dependences with experimental results is shown. It is established that the mechanism of transillumination proposed theoretically does not include the ways to control it under the preset wave frequency and parameters of the plasma formation, so it should be classified as the mechanism of quasitransparency of the wave barriers in plasma.

The experimental investigations [2] reveal a theoretically predicted transillumination [1] of the inhomogeneous plasma medium. The effect of transillumination of the wave barrier in a low-magnetized plasma is revealed for electron waves, which belong to the upper hybrid dispersion branch of oscillations in magnetized plasma. As was determined, this effect arises exactly due to the mechanism proposed in [1], although the plasma formation and wave type were different from that studied in the theory [1]. This is the evidence for that the range of a possible realization of such a transillumination is wider than described in [1], so the investigations of peculiarities of this effect are of certain interest.

The researches described below are the extension of those in [2]. Their objective was to carry out the detailed analysis of the peculiarities of realization of the mechanism of transillumination [1] in the plasma system under investigation and to define the dependence of transparency of the plasma barrier on the system parameters.

1. Experimental Setup

The investigations were performed using the experimental setup that included the gas-discharge system shown in Fig.1 and described in detail in [2]. The experiments were carried out in the same range of parameters of the non-self-maintained Penning discharge and of wave frequencies as in [2], namely: the discharge current I_a=0.1÷4 A, the discharge voltage V_a = 50÷150 V, the magnetic intensity H = 50÷200 Oe, the argon pressure in the discharge chamber $p = (1\div5)\cdot10^{-4}$ mm Hg, the wave frequency f= 490÷1000 MHz.

The probe technique was the same as in [2] and was used to determine stationary plasma parameters and their spatial distributions, the amplitude-frequency spectrum of plasma waves, and the spatial distributions of the intensity of their frequency components.

2. Peculiarities of Realization of the Mechanism of Transillumination

We consider the peculiarities of a realization of the transillumination predicted in [1] and revealed in [2], by using the real plasma formation with a barrier for upper hybrid electron waves in the low-magnetized plasma as an example, i.e. under conditions at which it was revealed [2].

The axial distributions (along the z axis) of the plasma potential $V(z)$ are presented in Fig. 2 for two values of the pressure in the discharge chamber for the case of plasma outflow into vacuum chambers through the holes (⌀ = 30 mm) in reflectors. These axial distributions were symmetric at a sufficient level of accuracy: $V(z) = V(-z)$. We can see that, when the gas pressure in the discharge chamber and consequently in the vacuum ones is increased, the plasma potential increases in the last, but the depth of the potential well and the potential gradient on its walls decreases. This effect is due to the ionization of the additional gas in the system.

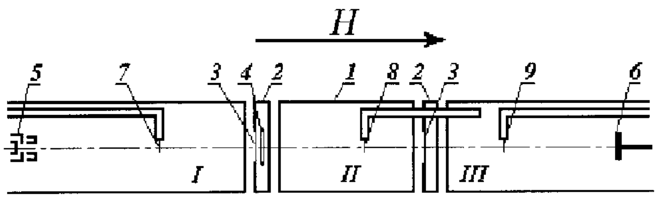

Fig. 1. Scheme of the gas-discharge system. *I, III* — vacuum chambers, *II* — discharge chamber, *1* — anode, *2* — cathode blocks, *3* — diaphragms, *4* — cathode, *5* — electron gun, *6* — collector, *7, 8, 9* — high frequency probes

The distribution of the plasma potential at various values of the argon pressure in the system is well approximated by the dependence

$$V(z) = \frac{V_0 - V_\infty}{1 + \exp\left(\frac{z - z_0}{\Delta z}\right)} + V_\infty, \qquad (1)$$

where V_0 is the plasma potential on the bottom of the potential well for electrons; V_∞ is the plasma potential at infinite distance from the barrier which depends on the gas pressure in the system; z_0 is the coordinate of the wall of the potential well at the one-half of its depth; Δz is the characteristic size of the area of the steep slope of $V(z)$. The approximation is valid when the condition $z_0/\Delta z >> 1$ is satisfied.

Accordingly to [1], the first necessary condition for the mechanism of transillumination to be realized is the phase focusing of probably all electrons or their certain group at least. This takes place when the time of electron movement from the point of synchronism z_s before the barrier (where the absolute value and direction of the wave phase velocity $v_{\rm ph} = \omega/k(z_s)$ coincide with those of the velocity of an electron $v_e(z_s)$, and it absorbs the energy with high efficiency) through the barrier to the point of its reflection from the wall of the potential well z_r (where v_e=0) and backward to the point of synchronism z_s behind the barrier does not depend on E in a certain interval of the kinetic energy of electrons E at the bottom of the potential well (z=0), i.e.

$$\frac{d\tau}{dE} = 0. \qquad (2)$$

For the case of the symmetric profile of the plasma potential,

$$\tau = 2\int\limits_0^{z_r} \frac{dz}{v(z,E)}, \qquad (3)$$

$$v(z,E) = \left\{\frac{2}{m}[E - e\,(V_0 - V(z))]\right\}^{1/2}. \qquad (4)$$

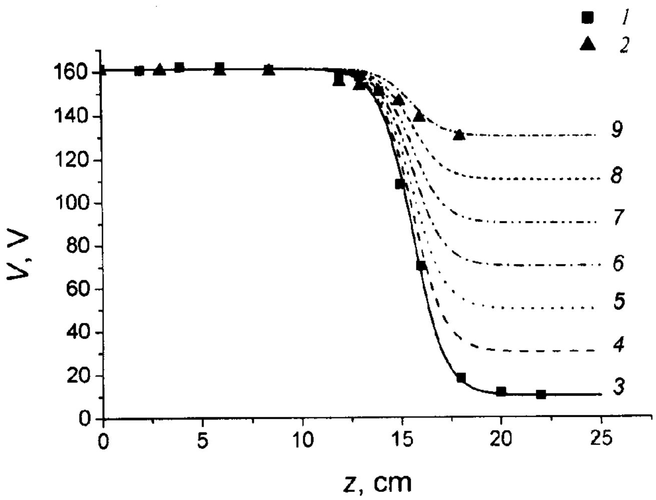

Fig. 2. Profiles of plasma potential in the system that were determined experimentally (*1, 2*) and calculated by formula (1) (*3–9*). *1* — $p = 1.3{\cdot}10^{-4}$ mm Hg, *2* — $p = 2.0{\cdot}10^{-4}$ mm Hg, *3* — $V_\infty = 10$ V, *4* — 30, *5* — 50, *6* — 70, *7* — 90, *8* — 110, *9* — 130

We introduce the normalized electron energy $\eta = \frac{E}{eV_0}$, the normalized potential $\varphi(z) = \frac{V(z)}{V_0}$, and the quantity $F = \frac{\tau}{2}\sqrt{\frac{2eV_0}{m}}$. Then condition (2) takes the form

$$\frac{dF(\eta)}{d\eta} = \frac{d}{d\eta}\int\limits_0^{z_r(\eta)} \frac{dz}{\sqrt{\eta - 1 + \varphi(z)}} = 0. \qquad (5)$$

As was found in [2], condition (5) realizes at the certain value of $\eta = \eta^*$, i.e. only electrons having the energy close to $E^* = e\eta^* V_0$ participate in the barrier transillumination.

The experimental data are presented in Fig.2 as well as the dependences $V(z)$ calculated by formula (1) for V_0= 161 V, z_0= 15.6 cm, Δz = 0.78, and for V_∞ from 10 to 130 V with a step of 20 V. This range of V_∞ corresponds to that observed experimentally under the increase in the pressure of argon from $1.3{\cdot}10^{-4}$ to $2{\cdot}10^{-4}$ mm Hg. The value of $\eta^*(V_\infty)$ and the coordinate z_r of the reflection point of the electrons with energy E^* from the wall of the potential well were determined using these profiles and condition (5). The results of these calculations are presented in Fig.3. We can see that the coordinate z_r practically does not change with V_∞ though the energy of these electrons decreases linearly, V_∞ being increased, i.e., when the depth of the potential well $V_0 - V_\infty$ decreases. At the same time, the ratio $\eta^* V_0/(V_0 - V_\infty)$ remains approximately constant.

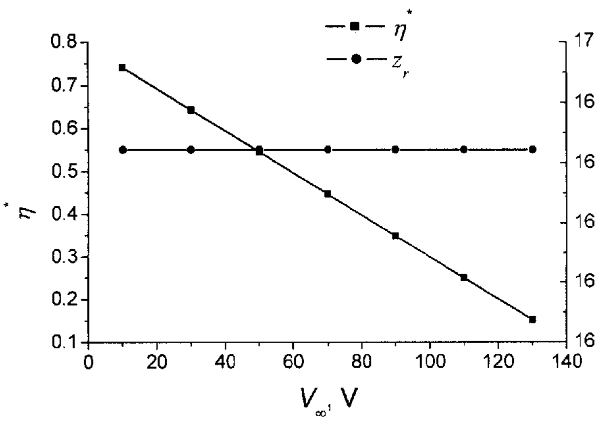

Fig. 3. Dependences of η^* and the coordinate of the point of reflection z_r of electrons with the energy $E^* = e\eta^* V_0$ from the wall of the potential well on the parameter V_∞

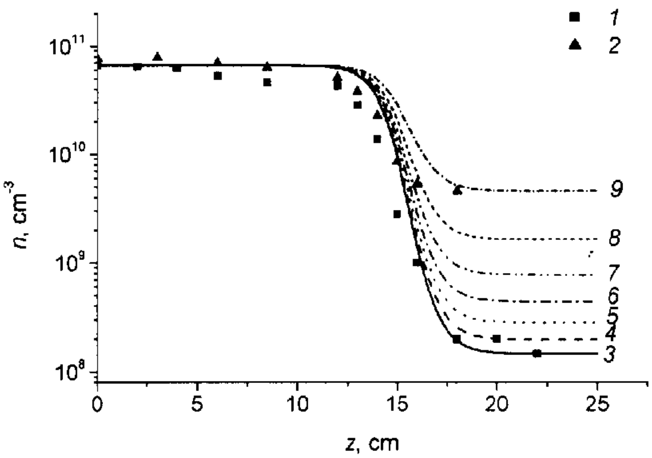

Fig. 4. Profiles of plasma density in the system that were obtained experimentally (*1, 2*) and calculated in (*3—9*) . The notations are the same as in Fig. 2

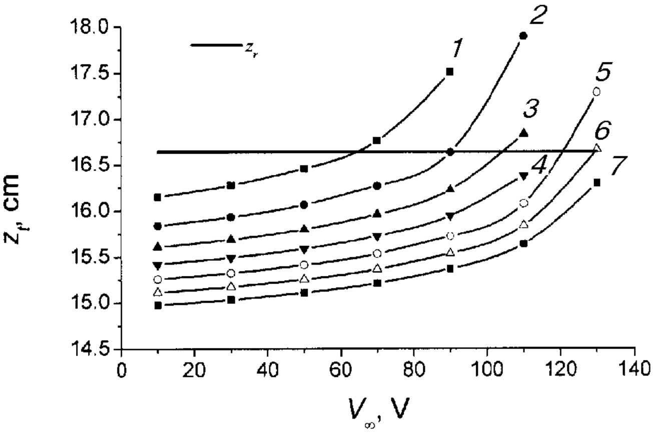

Fig. 5. Dependences of both the coordinate of the reflection point of phase-focused electrons $z_r(V_\infty)$ (solid line) and the coordinate of the barrier boundary $z_t(V_\infty)$ for the various modulation frequencies: *1* — f_m = 300 MHz, *2* — 400, *3* — 500, *4* — 600, *5* — 700, *6* — 800, *7* — 900

The experimental axial distributions of the plasma density, which correspond to the potential distributions *1* and *2* in Fig. 2, are presented in Fig. 4. As turned out, they can be approximated by the Boltzmann dependence

$$n(z) = n_{z=0} \exp \left[-e \frac{V_0 - V(z)}{T_e} \right], \qquad (6)$$

although the velocity distribution of electrons differs from the Maxwell one [3] in the range of high velocities. For this purpose, it is necessary to take into account the dependence of the effective temperature (of the energy) of electrons on the gas pressure (or on V_∞). This dependence was found to have the form

$$T_e/e = 25.77 - 0.109 V_\infty(\mathrm{V}) \qquad (7)$$

for the distributions presented in Fig.4.

The results of calculations of $n(z)$ at different V_∞ are presented in Fig.4 as well. They were used to calculate the phase velocity of the waves of the upper hybrid dispersion branch of the low magnetized plasma and its dependence on the coordinate z for the waves with various frequencies. This enables, having compared the dependences $v_{\mathrm{ph}}(z)$ and $\nu_e(z, \eta^*)$, to determine both the positions of the barrier edge, i.e. the point z_t, where the wave frequency $f_m = f_p = \sqrt{\frac{e^2 n(z_t)}{\pi m}}$ and $v_{\mathrm{ph}} = 0$, and of the point z_s of the synchronism of the waves and electrons.

The results of calculations of the dependences $z_t(V_\infty, f_m)$ for the data presented in Fig. 4, are shown in Fig. 5 together with $z_r(V_\infty)$. They indicate that the barrier width increases with V_∞ (with the gas pressure), but the width of the region $z_r - z_t$ decreases, and finally the point of reflection of the phase-focused electrons is found inside the plasma barrier, i.e. the second necessary condition of its transillumination is broken. The lower the wave frequency, the smaller values V_∞ (gas pressures) are needed for the barrier transillumination to be lost.

The variation of the value of $n_{z=0}$ sufficiently influences the realization of the mechanism of transillumination as well, $\varphi(z)$ and $n(z)/n_{z=0} \equiv \Psi[\varphi(\mathrm{z})]$ being constant. If the wave frequency is constant, an increase of the barrier height is automatically accompanied by its widening and by a decrease of the region $z_r - z_t$ to zero. After that, there are no points of synchronism. Thus quantity $n_{z=0}$ determines the lower

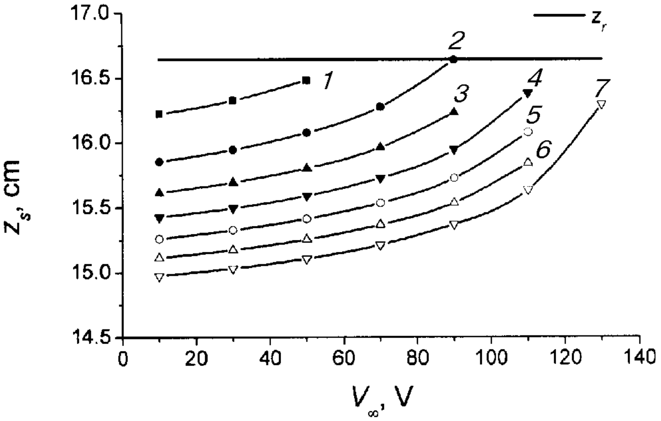

Fig. 6. Same dependences as in Fig. 5 for the coordinate of the point of synchronism z_s and the coordinate of the reflection point z_r

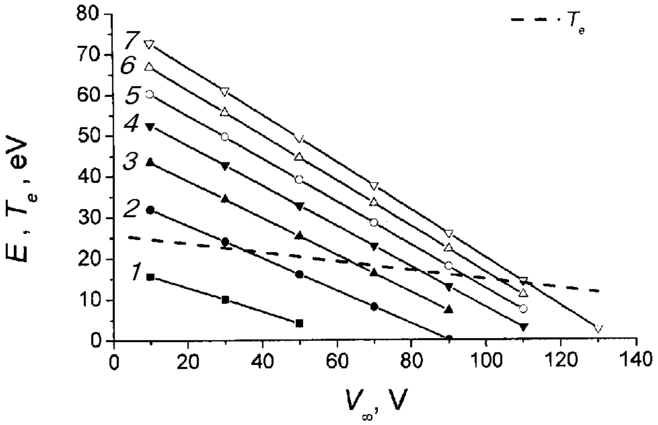

Fig. 7. Dependences of both the kinetic energy of electrons E at the point of synchronism z_s and the electron temperature T_e on the parameter V_∞. The notations are the same as in Fig. 5

limit of the frequency range of the waves for which the transillumination can be realized.

The dependences $z_s(V_\infty, f_m)$ and $z_r(V_\infty)$ are shown in Fig. 6. They indicate that the point of synchronism is shifted to z_r when V_∞ (the gas pressure) is increased, then the point reaches this coordinate and disappears after that, i.e. the transillumination becomes impossible by the mechanism in [1].

It is also known that, when the phase velocity of a wave approaches the thermal velocities of plasma electrons, the last intensively absorb the energy of the wave and its strong dumping is observed. From this point of view, the absolute values of the velocities of the phase-focused electrons or their energy at the point of synchronism are very important. The calculated plots of the kinetic energy E of these electrons at the points of synchronism z_∞ vs V_∞ (the gas pressure) for the various wave frequencies, as well as the plot of the temperature (of the energy) of the plasma electrons vs V_∞ are presented in Fig. 7. Comparing the data presented in Figs. 5 and 7, one can see that the relation $v_{\text{ph}} \approx v_{T_e}$ is satisfied before $z_t > z_r$, V_∞ being increased.

The inhomogeneity of the plasma is three-dimensional in the investigated system, as well as in the majority of the real plasma formations: the potential and density of the plasma are changed not only along the magnetic field, but also in the transverse direction. But, as follows from the analysis, these circumstances do not restrict the possibilities of the mechanism of transillumination [1] to be realized in principle. Indeed, let us assume that the spatial dependence of the plasma potential is

$$V(z,r) = V(z)\Phi(r), \tag{8}$$

where $V(z)$ is governed by dependence (1). For this case, both the value of η^* and the coordinate of the reflection of the phase-focused electrons from the wall of the potential well z_r do not depend on r. Hence, the mechanism of transillumination can be realized throughout the whole cross section of the column of plasma electrons which come through the barrier. It is important that the energy range of the plasma electrons participating in the transillumination is increased, since

$$E^* = e\eta^* V_0 \Phi(r). \tag{9}$$

The only consequences of the decreasing of the plasma density across the magnetic field are the decreasing of the barrier width and increasing of the distance from the barrier to the point of reflection of the phase-focused electrons from the wall of the potential well, which influences only the velocity of these electrons at the points of synchronism. The radial inhomogeneity of plasma can play a positive role in the case where, the point z_t appears inside the barrier on the axis of the plasma system and there is no transillumination of this barrier at this place. The narrowing of the barrier can bring the point z_r out of the barrier's limits under moving along the radius of the system, which can cause its transillumination with the ring-shaped intensity distribution of the waves, regenerated behind it.

3. Efficiency of the Transillumination of Plasma Barriers for Upper Hybrid Electron Waves

The transmission factor is a quantitative characteristic of the barrier transillumination and is determined by the ratio of the amplitude of the wave which is regenerated behind the barrier to that of the incident one. Unfortunately, the absolute value of the above-mentioned factor cannot be defined in the experiments carried out, because the plasma-probe coupling coefficients for the probe that generates waves and for one that receives the signal are unknown. Hence, the amplitudes of the waves generated in the plasma before the barrier and regenerated behind it are unknown too. It is only possible to evaluate the value of the transmission factor using the values of signals that were supplied to the generative probe and received behind the barrier, having assumed that the both mentioned coefficients are approximately equal to unity. These coefficients may be considered to be equal due to the fact that the designs and sizes of the generative and receiver probes are almost identical and that the probes are located in the plasma with almost the same parameters. In the present investigations, the transmission factor is of order of 10^{-3} under conditions which are optimal for the transillumination, as follows from evaluations using the wave amplitudes. In fact, it is the low estimate, since, as a rule, the coefficients of plasma-probe coupling are much lower than unity.

The analysis of peculiarities of realization of the mechanism of transillumination of a plasma barrier, that was given in the previous section, allows us to forecast (at a qualitative level) the functional dependences of the transillumination efficiency on the parameters of a plasma formation and on the frequency of the wave which propagates in it. Since the final stage of the mechanism of transillumination is the wave regeneration in the plasma behind the barrier by the modulated microflow of phase-focused "resonant" plasma electrons, the efficiency of the transillumination process depends on the density of electrons and their velocities in the regeneration zone, i.e. in the vicinity of the points of synchronism, on the absorption of the regenerated waves by plasma electrons, and on the degree of the plasma inhomogeneity in the regeneration zone.

The density of the phase-focused electrons, which regenerate a wave behind the barrier, depends on the plasma density at the top of the barrier ($z = 0$), the distribution function of plasma electrons at this point over the velocity component along the direction of their oscillation in the potential well, and on the energy of electrons $E^* = \frac{mv_z^{*2}}{2}$ at which the minimum of $\tau(E^*)$ is realized. The last, in turn, is determined by the configuration of the potential well and by the absolute value of its depth. In addition, the number of the phase-focused electrons is determined by the behavior of $\tau(E^*)$ in the vicinity of its minimum and by the wave frequency at which the transillumination is realized. The fact is that not only electrons with the energy of E^* take part in the wave regeneration behind the barrier, but also electrons having energies close to the mentioned one if they come (after their reflection) to the point of synchronism, at the latest, during a quarter of the period of oscillations after the phase-focused electrons. It is clear that the flatter the minimum of the dependence $\tau(E^*)$ and the lower the wave frequency, the larger is the number of electrons participating in the barrier transillumination and the higher is the efficiency of this process.

The velocity of the phase-focused electrons at the point of synchronism is determined by the wave frequency and by the distributions of plasma density and potential in the direction of its transillumination. A decrease of the wave frequency or an increase of the absolute value of the plasma density results in a decrease of the phase velocity at the point of synchronism (where it is equal to the velocity of the phase-focused electrons), the profiles of the plasma density and potential being constant. As long as the value of the mentioned velocity exceeds the thermal velocities of plasma electrons, this decreasing promotes the regeneration of a wave behind the barrier. Otherwise, the absorption of the regenerated wave by plasma electrons, which were created in this region due to the gas ionization processes, or by ones that come to the point of synchronism directly out of the barrier is engaged, and, conversely, the transillumination efficiency decreases with velocity value at the point of synchronism up to the complete loss of the effect at $z_s = z_t = z_r$ when $v_{\rm ph} = 0$.

Finally, we consider the influence of the degree of the plasma inhomogeneity at the point of synchronism. The ratio of the characteristic length of the plasma inhomogeneity $L = \left[\frac{d\ln n(z)}{dz}\right]^{-1}$ to the wavelength λ_z is the parameter that characterizes the influence. As was shown in [3], the generation of upper hybrid waves by the flow of fast electrons is worsened, this parameter being decreased. It is worth noting that the mentioned parameter has a sufficiently large value and the plasma inhomogeneity cannot influence the process of transillumination appreciably in those cases where the wave regeneration is realized practically on the barrier boundary in the region of small values of phase wave velocities.

As it is impossible to obtain experimental data concerning the absolute values of the transmission

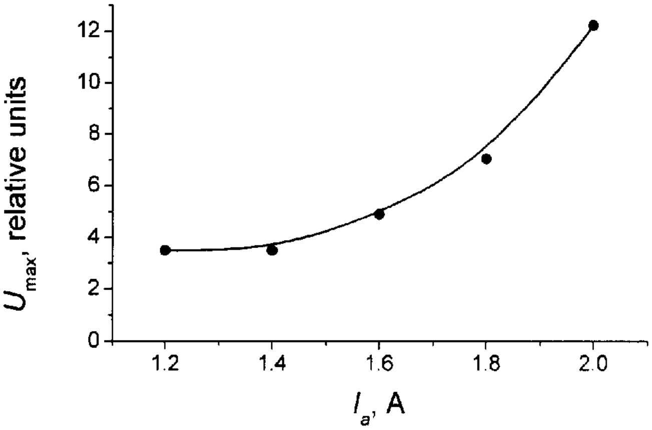

Fig. 8. Dependence of the signal intensity behind the barrier at the maximum of the axial distribution on the discharge current. $V_a = 85$ V, $p = 2{\cdot}10^{-4}$ mm Hg, $f_m = 500$ MHz

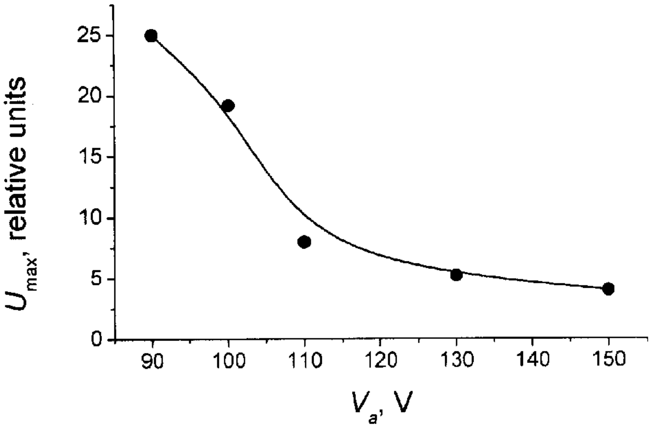

Fig. 9. Dependence of the signal intensity behind the barrier at the maximum of the axial distribution on the discharge voltage. $I_a = 1.0$ A, $p = 1.5{\cdot}10^{-4}$ mm Hg, $H = 120$ Oe, $f_m = 750$ MHz

factors of the barrier, the investigations were restricted to define the influence of the wave frequency and parameters of the discharge that created plasma on the quantity, which is proportional to the mentioned factor. As such a quantity, we take the value of the signal regenerated behind the barrier and supplied to the generative probe at the maximum of its axial distribution. We also assume that the coupling coefficients for both the probe-vibrator with plasma and the plasma with the measuring probe are constant, the amplitude of the high-frequency signal supplied to the probe-vibrator being constant.

We investigated the dependences of the barrier transparency on the following parameters: the discharge current, discharge voltage, argon pressure in the chamber, and frequency of the waves which were excited

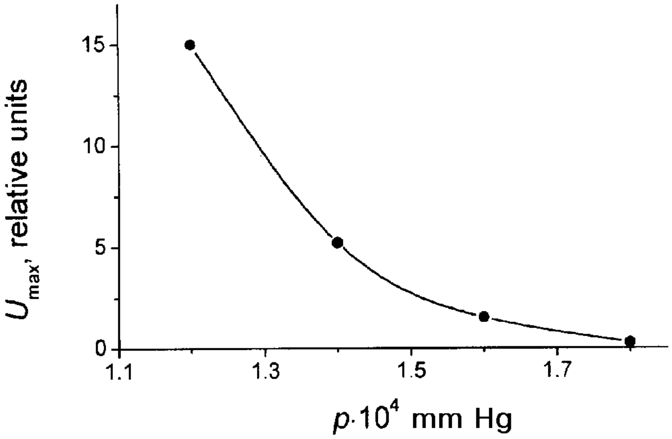

Fig. 10. Dependence of the signal intensity behind the barrier at the maximum of the axial distribution on the working gas pressure. $I_a = 0.8$ A, $V_a = 150$ V, $H = 133$ Oe, $f = 503$ MHz

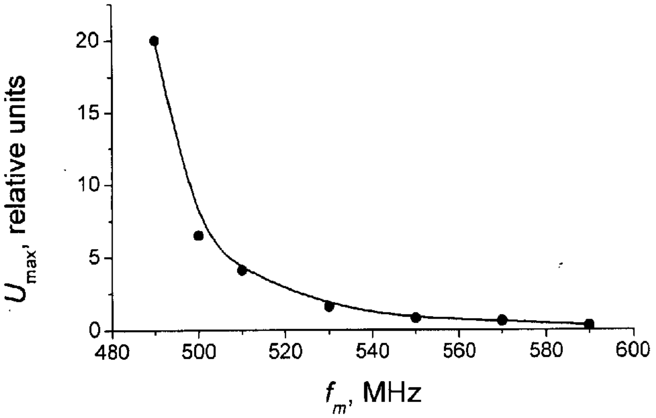

Fig. 11. Dependence of the signal intensity behind the barrier at the maximum of the axial distribution on the wave frequency. $I_a = 1.3$ A, $V_a = 85$ V, $p = 1.9{\cdot}10^{-4}$ mm Hg, $H = 133$ Oe

in the system. The investigations of the dependence of the barrier transparency on some of the given parameters were accomplished, all others being held constant. The results of the investigations carried out are presented in Figs. 8—11. We will show that they satisfy the conclusions of the above-stated analysis. To do this, first of all, we pay attention to some peculiarities of the plasma which is created by the non-self-maintained Penning discharge with a hot cathode and of this discharge itself.

When the plasma density is below 10^{12} cm^{-3}, the discharge current is governed mainly by the processes of the neutral gas ionization by primary electrons and increases with their energy and current and with the working gas pressure. In the discharges in heavy gases, for which a small radial drop of the potential is typical, the energy of primary electrons is defined by a cathode drop of the potential which is a few volts lower than the discharge voltage [4].

In the plasma, the distribution function of electrons over energy, which corresponds to the velocity component directed along the magnetic field, differs from the Maxwell one by the presence of a "tail" of fast electrons. This "tail" appears beginning from energies that exceed the thermal energy by the factor of 4÷5 and is terminated at the energy $E \approx eV_a$ [5] beyond the bounds of the column of primary electrons. The "tail" is formed mainly owing to the energy relaxation of the flow of primary electrons due to the collective processes of the beam-plasma interaction.

The dependence presented in Fig. 8 is obtained, both the discharge voltage and gas pressure in the discharge being constant. The increase of the discharge current was provided by an increase of the current of primary electrons. This implicates that the component of the energy spectrum of plasma electrons in its "tail," which provides the barrier transillumination, increases as well. On the other hand, the increase of the plasma density results in widening the wave barrier, in shifting the point of synchronism z_s to the point of the reflection of the phase-focused electrons z_r, and in decreasing the wave phase velocity in its vicinity. The ratio L/λ_s increases as well. The set of all these effects has to result in increasing the efficiency of transillumination that was confirmed experimentally.

The dependence presented in Fig. 9 is obtained, both the discharge current and argon pressure in the system being constant. The current of primary electrons is decreased to maintain a constant value of the discharge current, when the discharge voltage is increased and, hence, when the gas ionization process is intensified. As the configuration of the potential well $V(z)/V_0$ remains invariable and the gas pressure is sufficiently low, the value η^* remains constant, but the energy of the phase-focused electrons $E^* = e\eta^* V_0 \approx e\eta^* V_a$ increases. Consequently, the density of the phase-focused electrons decreases. As was determined experimentally, the transillumination efficiency decreases, when the discharge voltage is increased. This fact can be clearly explained by taking into account that, when V_a is increased, the intensity of the components of the "tail" decreases due to its extending.

The transillumination efficiency decreases with increase in the gas pressure in the system (see Fig. 10) and is a result of the competition of a number of processes. On the one hand, the depth of the potential well and the energy of the phase-focused electrons are decreased (see Figs. 2 and 3). The last, taking into account the character of the velocity distribution of plasma electrons, has to result in increasing the density of phase-focused electrons. The widening of the barrier (see Fig. 5) leads to decreasing the wave phase velocity at the point of synchronism. All of these have to promote the processes of wave regeneration behind the barrier. On the other hand, a decrease of the current of primary electrons to maintain the discharge current and voltage decreases the number of phase-focused electrons, and the decrease of the phase velocity of waves in the region of their regeneration to the thermal velocities of electrons results in the enhancement of the absorption of regenerated waves by them. It is obvious that the last factors, which do not promote the transillumination effect, dominate under those conditions at which the results presented in Fig. 10 are obtained. Probably, there is the combination of plasma system parameters that is optimal for transillumination the wave barrier in it. This is indicated by the results of experiments, which were carried out in the system with plasma coming out from the discharge through the smaller ($\varnothing$ = 20 mm) holes in the reflectors. The dependence of the barrier transparency on the gas pressure in such a system has a maximum.

The dependence of the barrier transparency on the frequency of the incident wave is presented in Fig. 11. This dependence is obtained at the fixed parameters of the plasma formation and may be attributed only to the shifting of the zone of existence of the wave, its frequency being changed. Indeed, as follows from the results of calculations presented in Fig. 7, when the frequency is changed from 500 to 600 MHz, the velocity of the phase-focused electrons increases by a factor of 1.1 at the point of synchronism. This can result in decreasing the regenerated signal by a factor of three. In addition, as was mentioned, a decrease of the number of electrons, which can participate in the wave regeneration, results in a decrease of the generation efficiency too when the frequency is increased. Thus, the barrier transparency has indeed to decrease, the frequency of the wave that falls to the barrier being increased.

As for the localization of waves regenerated behind the barrier, their maximum of intensity is detected in the region $13 < z_{\max} < 17$ cm throughout the range of the experimental variation of discharge parameters and wave frequencies (see Figs. 2 and 4), that is in the region of the strong plasma inhomogeneity. The calculations show that the points of synchronism (see Fig. 6) have to

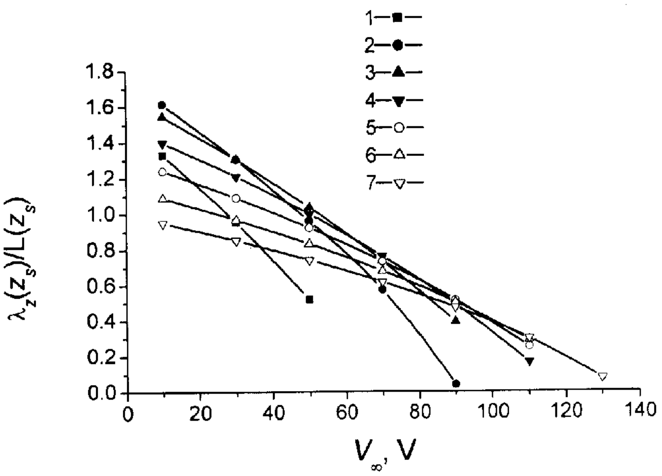

Fig. 12. Dependence of the ratio of the upper hybrid wavelengths to the plasma inhomogeneity parameter at the corresponding points of synchronism z_s on the parameter V_∞ for the various modulation frequencies (*1—7*). The notations are the same as in Fig. 5

realize namely in this region, where the regeneration of waves, whose lengths are close to the characteristic length of plasma inhomogeneities, takes place (see Fig. 12).

Conclusions

We have investigated the peculiarities of a realization of the plasma barrier transillumination which was revealed in [2] for the electron waves of the upper hybrid dispersion branch of oscillations in a low-magnetized plasma and have got the additional evidences for that the transillumination is realized accordingly to the mechanism that was predicted theoretically in [1]. The efficiency of the process of transillumination is governed by the wave frequency and by the plasma formation parameters only. If the last are fixed, there are no ways to influence the transillumination efficiency. From this point of view, the mechanism of transillumination of the plasma barrier forecasted in [1] does not differ from those proposed in works [6—8]. As a matter of fact, the mentioned mechanism is a mechanism of quasitransparency of a barrier rather than that of transillumination.

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ЕКСПЕРИМЕНТАЛЬНЕ ДОСЛІДЖЕННЯ ОДНІЄЇ МОЖЛИВОСТІ ПРОСВІТЛЕННЯ НЕОДНОРІДНОЇ ПЛАЗМИ. 2. ОСОБЛИВОСТІ РЕАЛІЗАЦІЇ ПРОСВІТЛЕННЯ ПЛАЗМОВОГО БАР'ЄРА ДЛЯ ЕЛЕКТРОННИХ ХВИЛЬ У СЛАБКОЗАМАГНІЧЕНІЙ ПЛАЗМІ

Д.Б. Палецъ, Л.І. Романюк

Резюме

Досліджено особливості реалізації просвітлення плазмового бар'єра для верхньогібридних електронних хвиль у слабкозамагніченій неоднорідній плазмі за механізмом, що базується на кінетиці електронів плазми, захоплених у потенціальну яму плазмового утворення, та їх фазовому фокусуванні. На підставі аналізу цих особливостей спрогнозовано залежність ефективності просвітлення бар'єра від частоти хвилі і параметрів плазмової системи. Показано якісне узгодження прогнозованих залежностей з отриманими експериментально. Встановлено, що теоретично запропонований механізм просвітлення не містить важелів впливу на нього при заданих частоті хвилі і параметрах плазмового утворення, а тому його доцільно віднести до механізмів квазіпрозорості хвильових бар'єрів у плазмі.