COMBINATIONAL PLASMA WAVES IN LOW-HYBRID ELECTRONIC REGION

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ABSTRACT

Injection of the charged particles beams in plasma or interaction of variable electromagnetic fields with it results in occurrence of instability fascicular and parametrical type

Keywords: combinational plasma, waves, low-hybrid electronic region, frequency, spectrum.

I. INTRODUCTION

Studying of such processes important [1-4] from the point of view of development of ways of heating of plasma in the devices suggested on a way of the decision of a problem of controlled thermonuclear synthesis, devices in which plasma serves for generation and transformation of various waves. With fascicular instabilities plasmas are integrally connected researches in the field of the plasma electronics, new collective methods of acceleration of particles, ionic and plasma engines.

In the present work it is shown, that interaction of these waves results in occurrence in plasma of a rich spectrum of combinational frequencies practically in all area low-hybrid electronic waves to filling an initial spectrum with the big number of own fluctuations simultaneously raised in a column. Thus three-wave combinations satisfy with the corresponding law of preservation. All investigated fluctuations concern to low- hybrid electronic beam.

At moderate intensities of external field pumping in a plasma column when simultaneously exists parametrically excited waves and a wave generated by an electronic beams the combinational frequencies which are growing out of interaction of these two types of waves are observed.

II. RESULTS AND DISCUSSION

Fig.1. shows, that the frequency spectrum of fluctuations observable in plasma in conditions of excitation as parametrical resonances $\omega_n = n\omega_0$ of a field pumping, and low-hybrid wave ω_T connected to an electronic beam. At a spectrum there are frequencies $\omega_n = n\omega_0$, ω_T and in each interval between next two combinational frequencies Ω_n are observed and Ω'_n (the sense of an index and is clear from a photo of a spectrum; in this case $\Omega_3 = \omega_T$).

At change of speed of electrons beam, stimulating slanting of Langmuir wave, frequency of this wave and, con formity with it varies, frequencies of combinational waves vary.

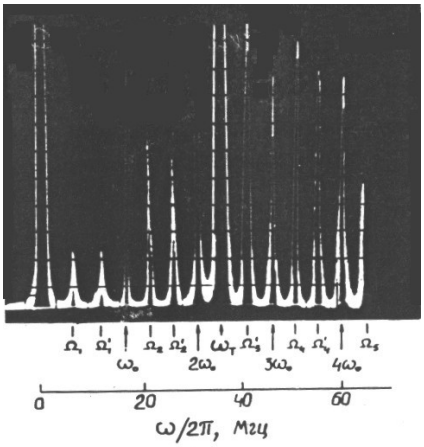

Fig. 1

On fig. 2 dependences of frequencies of a spectrum on speed of electrons beam, stimulating low-hybrid electronic wave (and electrons accelerating voltage) are submitted. All combinational frequencies Ω_n linearly grow, and frequencies Ω'_n fall with speed of a bunch. It will easily be convinced, that the observable spectrum corresponds to relations

$$\left.\begin{aligned}\Omega_n &= \omega_T + (n-m+1)\omega_0 \\ \Omega'_n &= (n+m)\omega_0 - \omega_T\end{aligned}\right\} \qquad (1)$$

where n=1,2,3 …., and m- means the place" of frequency $\omega_n = n\omega_0$ in spectrum $m\omega_0 < \omega_T < (m+1)\omega_0$ (on fig. 1,2 m=2). If in system of the equations to accept m=2 and n=1,2,3 …. all frequencies Ω_n and Ω'_n, filling a spectrum in experiment turn out. Thus, the combination (sum and difference) parametrical excited frequencies $n\omega_0$ and frequencies ω_T of the intensive wave connected to an electronic

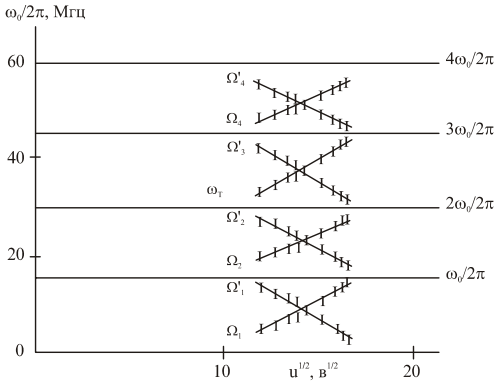

Fig. 2

beam is simultaneously realized. Measurements have shown, that combinational waves satisfy the dispersions of low- hybrid electronic waves.

$$\omega = \omega_{pe} \frac{k_{//}}{k_{\perp}} \quad (2),$$

where $\left[k = (k_{//}^2 + k_{\perp}^2)^{\frac{1}{2}}\right.$ -is the wave number $\left. k_{//} << k_{\perp}\right]$. For example, for lowest of combinational frequencies Ω_1 the distribution of variable potential in space (fig. 3) shows presence of a wave in the plane of xz (the energy of electronic beam is 200эv; a high-frequency pumping voltage $U_0 = 75V$). The relation of components of wave vector $\frac{k_z}{k_x} \sim \frac{1}{9}$ to within 2 will be coordinated to size $\frac{\Omega_1}{\omega_{pe}}$, i.e. is in the consent with a dispersion (2). In a spectrum of waves excited in researched system, the most low-frequency branches Ω_1 and Ω_1', ω_0, Ω_2 , Ω_2' resonances with thermal electrons. So for a wave Ω_1 phase speed along a magnetic field $\frac{\Omega_1}{k_{z1}} = 10^8$ sm /s < v_{Te} i.e. thus $\kappa_x d_e$ =0,7. This condition corresponds to $\Omega_1 = \omega_T - 2\omega_0 = .$ $= (k_{\omega Tz} - k_{2\omega 0z}) V_{ez}$ To induced dispersion of waves ω_T u $2\omega_0$ on thermal electrons via a combinational wave Ω_1. This mechanism apparently, is one of channels of carry of energy of fluctuations in area of lower electronic frequencies and to absorption by electrons. Experimental researches of behaviour thus function of distribution electrons with the help of probes was at a loss presence of high variable potentials in pumping fields.

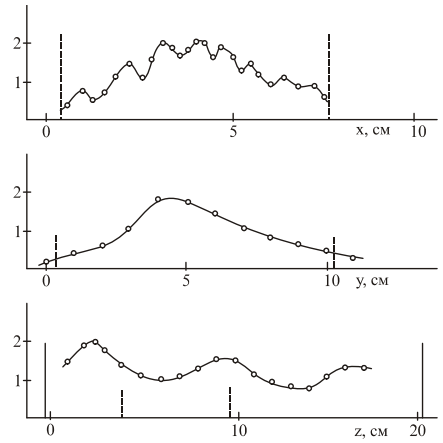

Fig. 3

III. CONCLUSION

Thus, it is shown, that in magnetizated plasma column conditions for excitation of the discrete combinational waves which are growing out of interaction of parametrical resonances on frequencies, multiple to pumping frequency ($\omega_n = n\omega_0$), and intensive of low- hybrid wave raised by an electronic beam are realized. Laws of conservation of energy and a pulse for three-wave processes together with the law of a dispersion explain an opportunity of simultaneous excitation of many combinational fluctuations in this system.

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