On theory of motion of electron in the combined magnetic trap during passing the domain of cyclotron resonance [[1]](#footnote-1)\*)

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It was shown in the papers [1], that an electron moving in the magnetic field and in the HF standing wave at the conditions of cyclotron resonance, sustaining with the help of slowly growing in time magnetic field, can obtain considerable energy. This regime of electron motion was named “gyromagnetic autoresonance” (GA) and was realized in the different experimental devices [2], [3]. Due to the complexity of the physical processes occurring in the devices their theoretical analysis was successfully carried out by the numerical methods [3]. In the given report we present some analytical calculations of the motion of an electron in a combined magnetic trap as it passes through the region of cyclotron resonance based on a simplified model where the vectors of the HF field of the cavity are approximated in the form of an exact solution of the Maxwell’s equations. Mirror magnetic field is defined in the paraxial approximation and it is assumed that it also depends on time in order to sustain the conditions of cyclotron resonance with a relativistic change in the cyclotron frequency. By replacing variables the relativistic equations of motion of electron are reduced to the system of equations of two coupled oscillators executing force transverse oscillations and to the equation for the longitudinal motion. Solution of the obtained equations with the possibility of passing through the region of cyclotron resonance is obtained by the method of Bogolyubov [4] with the help of expansions in terms of the small parameter which is the ratio of the amplitude of the oscillations of an electron velocity in the HF field of the cavity to the speed of light. The conditions are obtained that make it possible, in the first approximation consider coupled oscillators as independent. These conditions are immediately related to the possibility of maintaining resonance for a certain period of time. We are looking for a solution in the form of force oscillations, amplitude and phase of which are determined by the equations in which the right-hand sides are represented as expansions the terms of the small parameter. Rather complicated calculations are performed in the weakly relativistic approximation. The law of the transverse motion of an electron and the time dependence of the transverse components of the velocity vector in the fixed transverse plane of the trap are found under the given initial conditions. The general formula is also presented for the estimating of the averaged energy that electrons acquire when passing through the region of cyclotron resonance. Taking into account the obtained formulas for the transverse variables, the equation for the longitudinal motion of the electron is transformed. Its solution can be found by the numerical methods.

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Lt/ru/FH-Milant'ev.docx) [↑](#footnote-ref-1)