Capture of electrons into regime of synchronous acceleration in the combined magnetic trap [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2021.48.1.115

V.P. Milant’ev

Рeoples Friendship University of Russia, Moscow, Russian Federation, [milantyev\_vp@pfur.ru](mailto:milantyev_vp@pfur.ru)

For maintenance of cyclotron resonance of electrons with wave it was proposed in [1] to use the guiding magnetic field slowly growing in time. This mechanism of acceleration, named as gyromagnetic autoresonance, is successfully realized in the combined magnetic trap [2] which consists of the cylindrical cavity of the ТЕ111 mode immersed into the mirror magnetic field. Theoretical studies [2] are performed by the numerical calculations under the conditions maximally closed to the experiment. But the problems, connected with the features of the capture of electrons into regime of the synchronous acceleration are still not sufficiently investigated. In the given report we consider such problems. The relativistic equations of electron motion in the combined trap of the mentioned type are taken as the basic equations. Phases of the cyclotron rotation and the standing wave as well as their combinations are separated. Equations averaged over the fast phases describing the motion of an electron in the region of cyclotron resonance are obtained. It is supposed that synchronism of an electron with the wave is sustained with help of the slowly linearly growing guiding magnetic field during some time interval. The formal solution of the averaged equations is obtained which represents in fact integral relation between the dynamical variables of an electron. It is supposed that the condition of cyclotron resonance takes place in the middle of the trap, so one can neglect the space dependence both of the mirror magnetic field and field of resonator. Approximate equation for the resonant phase is obtained which has the form of nonlinear oscillator with two-humped potential energy [3]. Integral of “energy” allows us to do analysis of the phase trajectories of the trapped and transit particles under the condition that electron momentum is given. Resonant phases in the equilibrium state are found. It is shown that the parameter, which characterizes the pace of growing in time of the guiding magnetic field, should be essentially less than dimensionless parameter of the wave intensity. Approximate conditions for the capture of electrons into the regime of synchronous acceleration are obtained. It is shown that the capture of electrons is very limited which is connected with the relatively small depth of the potential pit at the conditions under the consideration. Under the more exact consideration of the capture conditions it is necessary to solve self consistent system of equations including evolution of the space variables, components of the momentum vector and the resonant phase. Such a problem should be solved by the numerical methods.

This study was funded by the Russian Foundation for Basic Research (project no. 18-29-21041).

References

1. Golovanivsky K.S. Phys. Scripta. 1980, 22, 126; IEEE Trans. Plasma Sci. 1983, **11**, 28.
2. Andreev V.V., Chuprov D.V., Ilgisonis V.I., Novitsky A.A. and Umnov A.M. Phys. Plasmas, 2017, **24**, 093518
3. [Sagdeev](https://www.google.ru/search?hl=ru&tbo=p&tbm=bks&q=inauthor:%22R.+Z.+Sagdeev%22) R. Z.**,** [Usikov](https://www.google.ru/search?hl=ru&tbo=p&tbm=bks&q=inauthor:%22Dani%C4%97l%CA%B9+Alekseevich+Usikov%22) D.A.[and Zaslavsky](https://www.google.ru/search?hl=ru&tbo=p&tbm=bks&q=inauthor:%22George+M.+Zaslavsky%22)G. M.Nonlinear Physics: From the Pendulum to Turbulence and Chaos //Harwood Academic Publishers, 1988

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