FEATURES OF THE ECR DISCHARGE ELECTRODYNAMICS IN A resonaTOR [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.215

1Dvinin S.А., 2,3Korneeva M.A.

1Lomonosov Moscow State university, [s\_dvinin@mail.ru](mailto:s_dvinin@mail.ru)   
2RUDN University, [korneevama@mail.ru](mailto:korneevama@mail.ru),  
3Federal State Institution «Scientific Research Institute for System Analysis»  
  of the Russian Academy of Sciences

Electron cyclotron resonance discharges are used in modern physics to create sources of multiply charged ions, hydrogen ions for proton accelerators, spacecraft engines, and plasma-chemical installations for processing materials [1]. The work is a continuation of [2], which considers the characteristics of a discharge in a magnetic trap placed in a cylindrical resonator. The axial magnetic field in a magnetic trap increases in the axial direction and decreases in the radial direction. The resonator is excited by a rectangular waveguide (mode H10) through a narrow slot in the side wall. The wide wall of the waveguide is parallel to the 0Z axis. The cyclotron frequency ΩС0 at the discharge center can be less, equal, or greater than the field frequency ω. The plasma is excited in a cylindrical quartz bulb, which occupies most of the resonator. The change in the structure of the electromagnetic field with a change in the electron density ne in plasma is studied. A ratio of the electron collision frequency ν to the field frequency ω is ν/ω=0.1. The spatial distribution of the electromagnetic field and the discharge impedance were calculated using the Comsol Multiphysics® package.

An analysis of the spatial distribution for ω=ΩС0 showed the following most typical field structures:

1. At very low densities, the perturbation of the resonator field by the plasma is small. The spatial distribution corresponds to the field of the mode for which the field frequency is closest to the resonant one. In this region, the absorption of the plasma-exciting wave in the resonator is proportional to the electron density.

2. With a further increase in ne, the field in the plasma can be represented as traveling waves propagating from the resonator excitation region by the waveguide to the resonance region, where ω~ΩС, in which the main absorption occurs.

3. In those cases when the plasma density at the bulb boundary is high enough for the excited waves to begin to be reflected from the plasma boundary, an electromagnetic wave is formed that propagates along the side boundary of the bulb in the azimuthal direction. The penetration of the field into the resonant region decreases.

4. A further increase in the electron density leads to a decrease in the absorption of the wave propagating in the azimuthal direction and the formation of an azimuthal periodic structure.

The paper proposes analytical approximations for the electromagnetic field in the cases under consideration.

References

1. Wu W., Zhang A., Peng S. et al. Vacuum. 2020, V. 182. 109744. <https://doi.org/10.1016/j.vacuum.2020.109744>
2. Dvinin S.A., Korneeva M.A. Proceeding of XLIX Zvenigorod international conference on plasma physics and controlled fusion. ICPAF-2022. Zvenigorod, 18–22 March 2022, p. 186.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Pt/ru/HA-Dvinin.docx) [↑](#footnote-ref-1)