study of kinetic instabilities in helium plasma of a continuous ECR discharge [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.152

1,2Kiseleva E., 1,2Izotov I., 1,2Viktorov M., 1,2Skalyga V., 1,2Polyakov A.

1Federal Research Center Institute of Applied Physics of the Russian Academy of Sciences, Nizhny Novgorod, Russia, , dir@ipfran.ru,
2Lobachevsky State University of Nizhny Novgorod, Nizhny Novgorod, Russia, unn@unn.ru.

The kinetic instabilities of whistler-mode waves occurring in plasma are often encountered in space. In the Earth's magnetosphere, such waves arise due to energetic resonant particles propagating at a small angle to the magnetic field that traps them. The processes occurring in space can be well studied in the laboratory. For example, whistler waves often arise in the plasma of a discharge maintained under electron cyclotron resonance (ECR) conditions. This is due to the presence of an unstable and anisotropic distribution function of energetic electrons.

One of the important areas of research in the field of ECR ​​ion sources is to increase their efficiency. It is carried out mainly by improving the magnetic confinement systems and the parameters of the heating radiation that maintains the discharge. However, as was shown earlier (for example, [1]), the parameters of the extracted ion beams are significantly affected by the kinetic processes occurring in the plasma. Accordingly, in order to further improve performance and obtain ions with higher charges, it is necessary to take into account the energy distribution of electrons in such plasma.

In the present, the shape of the electron energy distribution function (EEDF) for the ECR plasma still remains unknown. However, in 2012, the team from the IAP RAS presented a method for measuring the energy distribution of electrons that left the plasma [2]. It allows estimating the hot (from units of keV to units of MeV) electronic component.

In this work, the kinetic instabilities that arise in the helium plasma of an ECR ion source with a high unit energy input were studied. The experiments were carried out in the gas-dynamic (collisional) confinement mode in a wide range of significant parameters of the power of the heating radiation of the gyrotron and the pressure of the neutral gas. Diagnostics of radiation in the microwave range was carried out which characterized the development of kinetic instabilities. The energy distributions of hot electrons that left the plasma were also measured. The optimal regimes for the development of kinetic instabilities in the helium plasma of an ECR discharge were found.

This research was supported by the grant of Russian Science Foundation № 21-12-00262.

References

1. I. Izotov, D. Mansfeld et al. Beam current oscillations driven by cyclotron instabilities in a minimum-*B* electron cyclotron resonance ion source plasma. Physics of Plasmas 19, 122501, 2012.
2. S.V. Golubev et al. Experimental electron energy distribution function investigation at initial stage of electron cyclotron resonance discharge. Review of Scientific Instruments. –– 2012. –– Vol. 83, no. 2. –– P. 02B504.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/EX-Kiseleva.docx) [↑](#footnote-ref-1)