INFLUENCE OF SPATIAL DISPERSION ON THE DIELECTRIC RESPONSE OF PLASMA WITH STRONG SPATIAL INHOMOGENEITY [[1]](#footnote-1)\*)

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Khusainov T.A.

IAP RAS, Nizhny Novgorod, Russia, [hta@ipfran.ru](mailto:hta@ipfran.ru)

The problem of the simulation of electromagnetic wave propagation in anisotropic inhomogeneous media with spatial dispersion is currently an important one. In particular, this is due to the widespread use of microwave plasma heating in magnetic fusion devices, and the development of technology and the increase in available heating power naturally require an increase in the quality of modeling.

In modeling, one of the difficulties is taking into account spatial dispersion in inhomogeneous media, since the dielectric permittivity tensor is usually known only in the quasi-homogeneous approximation, when spatial dispersion is determined for a homogeneous medium, and the spatial inhomogeneity is introduced approximately by taking into account the spatial inhomogeneity of the plasma and magnetic field parameters. Such an approximation is suitable for ray tracing, but it may not be enough for a full-wave simulation.

Besides, existing theories describing the response of the plasma beyond the quasi-homogeneous approximation consider only particular cases and are not suitable for working with general inhomogeneity. Among such works, one can note the work where the quasi-homogeneous approximation was further refined using energy relations [1] and the work where the response of a plasma with two-dimensional inhomogeneity across the external magnetic field was found by expansion in a small parameter: the ratio of the Larmor radius to the wavelength [2].

In this paper, we will discuss an original approach to the analysis of the dielectric response of a warm inhomogeneous plasma, the main idea of which is to analyze the function instead of the response for a plane wave , which is the core of the integral form of the response representation:

The integral core in this approach is explicitly determined from the solution of the linearized kinetic equation, and depends only on the parameters of the unperturbed electron trajectories and their distribution function. The core completely describes all the features of the plasma response, and it has the physical meaning of the response of the medium to a point electric field, which turned on at time at a point with coordinate . The approach allows us to consider media with arbitrary heterogeneity from the first principles, and the analysis is further simplified by the fact that the inhomogeneity of the probe field does not superpose with the inhomogeneity of the medium.

In this paper, using the example of several model media, we will consider the interference of spatial dispersion and spatial inhomogeneity, and study the limits of applicability of the quasi-homogeneous approximation.

References

1. Balakin A. A., Gospodchikov E. D., J. Phys. B: At. Mol. Opt. Phys., 2015, V. 48, P. 215701.
2. Sakharov A.S., Plasma Phys. Rep., 2017, V. 43, P. 1065.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Mu/ru/AJ-Khusainov.docx) [↑](#footnote-ref-1)