Limiting Absorption Principle for Singular Solutions to Maxwell Equations and Plasma Heating

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Abstract

There is currently interest in the heating of plasmas in tokamaks with electromagnetic waves, for example in the context of the project ITER. I will present recent results that show that it is possible to heat plasmas by means of hybrid resonances and I will give a formula for the absorbed energy.

The mathematical problem consists in the study of degenerate Maxwell equations in non-homogeneous and anisotropic media, that are not in classes that can be analyzed with the standard theories. It was necessary to consider singular integral equations of the third kind. A similar type of equations was considered by D. Hilbert and E. Picard at the beginning of the last century, and by some other authors after that. We study these equations by a limiting absorption principle that is motivated by the physics of the problem. We prove that there are locally integrable solutions and singular solutions that contain delta functions and principal values. The later are the only ones that heat the plasma. Furthermore, our results give a method for the numerical calculation of the solutions and I will present the numerical results obtained with our method.These original contributions to the theory of integral equations are of independent interest, and will probably have applications in other areas of science and engineering. As is well known, the limiting absorption principle is a very important tool in spectral and scattering theory and there is a very extensive literature on its use in quantum mechanics and in wave propagation. On spite of this, it appears that it has not been used before for singular solutions, as in our work.

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