Derivation of the Zakharov equations

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The Zakharov equations are a fundamental nonlinear model for the description of laser-plasma interactions. They were derived by V. Zakharov and his collaborators in the seventies and are now widely used, both for theoretical considerations and for numerical simulations.

We give a rigorous justification of the Zakharov equations, starting from the Euler-Maxwell equations, a complex, hydrodynamic model for laser-plasma interactions.

Precisely, we prove that, in the high-frequency limit, solutions of the Euler-Maxwell equations are well approximated by solutions of the Zakharov equations. This work relies mainly on the techniques of geometrical optics developed by J.-L. Joly, G. Métivier and J. Rauch in the nineties. Because of transparency properties of the Euler-Maxwell equations, this study is led in a highly-nonlinear regime.