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High field limit for the Boltzmann equation

We consider the High field limit of the Boltzmann equation of semiconductors

$$\partial_t f_\varepsilon + v \cdot \nabla_x f_\varepsilon + \frac{1}{\varepsilon}\big(E \cdot \nabla_v f_\varepsilon - Q(f_\varepsilon)\big) = 0.$$

The collision operator Q is nonlinear and the parameter ε which measures the mean free path as well as the inverse scale of the force field E is assumed to be small.

The limiting equation is a nonlinear conservation law. Thanks to a Hilbert expansion method and to the L^1 contractivity of both the kinetic and the limiting equations, we show the convergence of the kinetic solutions towards the solution of the limiting conservation whenever the latter is smooth.

Then, we derive a series of entropies for the kinetic equation, which "converge" to the convex entropies of the limiting conservation law. By using these entropies, we prove the convergence as ε tends to zero, of the kinetic solutions f_ε towards the unique entropy solution, even when shocks do appear. The same entropy allows to construct kinetic profiles for entropic shocks. Diffusive correction can be handled by a linearized version of these entropies.

This is a work in collaboration with Hédia Chaker (Tunis) and Christian Schmeiser (Vienna).