Kinetic limit of dynamical description of wave-particle self-consistent interaction in an open domain

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We consider a system of N charged particles $\sigma^N = (x_1, v_1, ..., x_N, v_N)$ interacting via a pair potential U in a defined closed region Ω of space. In this region, particles also interact self-consistently with one wave $Z = A\exp(\mathrm{i}\phi)$. We consider injection of particles in Ω, so N varies in time.

Given initial data $(Z^N(0), \sigma^N(0))$ and a boundary source/sink, the system evolves according to a Hamiltonian to $(Z^N(t), \sigma^N(t))$. In the limit of infinitely many particles (kinetic limit), this generates a Vlasov-like kinetic equation for the distribution function $f(x, v, t)$ coupled to an envelope equation for Z, labeled Z^∞. The solution (Z^∞, f) exists and is unique for any initial data with finite energy, given that Ω has smooth enough boundaries.

Further, for any finite time t, given a sequence of initial data such that $\sigma^N(0) \to f(0)$ weakly and $Z^N(0) \to Z(0)$ as $N \to \infty$, the states generated by the Hamiltonian dynamics $(Z^N(t), \sigma^N(t))$ are such that $\lim_{N\to\infty}(Z^N(t), \sigma^N(t)) = (Z^\infty, f(x, v, t))$.

References

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