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Existence and Uniqueness for a System of a Solid in a Lorentz Gas

To accurately model the motion of an object immersed in a rarefied gas, one must construct a coupled system where the gas density evolves according to a partial differential equation with boundary conditions determined by the object motion, and the object evolves following Newton's Laws which depend on the gas density. The existence and uniqueness of solutions to this system of coupled equations is an open problem for all but one-dimensional non-interacting (ideal) gasses. We show the existence and uniqueness of a one-dimensional Lorentz gas density given arbitrary object motion. Furthermore, we show the same for the entire system of Lorentz gas and object motion assuming monotonically increasing object speed. This provides theoretical justification to the application of these models to make predictions about Lorentz gas-object interaction systems and develops strong foundations towards proving existence and uniqueness in more generality.