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The Vlasov-Poisson system with a uniform magnetic field: propagation of moments and regularity

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The Vlasov-Poisson system is a set of PDE's that govern the evolution of a cloud of particles in astrophysics or plasma physics. Here, in a plasma physics framework, we're interested to see what happens for charged particles when we add a uniform magnetic field.

More precisely, this work deals with the propagation of moments in velocity for the 3-dimensional Vlasov-Poisson system with a uniform magnetic field $B = (0, 0, \omega)$ by adapting the work of Lions, Perthame (Propagation of moments and regularity for the 3-dimensional Vlasov-Poisson system, 1991).

The added magnetic field produces singularities at times which are the multiples of the cyclotron period $t = \frac{2\pi k}{\omega}$. We get around this by noticing that our estimates depend only on the initial condition and constant parameters, which means our logarithmic estimate for the force field is true at all time. This result also allows to show propagation of regularity for the solution.

For uniqueness, we extend Loeper's result (Uniqueness of the solution to the Vlasov-Poisson system with bounded density, 2006) by showing that the set of solutions with bounded macroscopic density is a uniqueness class.

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