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Finite N corrections to Vlasov dynamics and the range of pair interactions ANDREA GABRIELLI, Institute of Complex Systems (ISC) - CNR (Italy), MICHAEL JOYCE, JULES MORAND, LPNHE - Univ. Paris VI "Piérre et Marie Curie" (France) — We explore [1] the conditions on a pair interaction for the validity of the Vlasov equation to describe the dynamics of an interacting N particle system in the large N limit. Using a coarse-graining in phase space of the exact Klimontovich equation for such a system, we evaluate the scalings with N of the terms describing the corrections to the Vlasov equation for the coarse-grained one particle phase space density. Considering an interaction with radial pair force $F(r) \sim 1/r^a$, regulated to a bounded behavior below a "softening" scale l, we find that there is an essential qualitative difference between the cases $a<d$ (i.e. the spatial dimension) and $a>d$, i.e., depending on the the integrability at large distances of $F(r)$. For $a<d$ the corrections to the Vlasov dynamics for a given coarse-grained scale are essentially insensitive to the softening parameter l, while for $a>d$ the corrections are directly regulated by l, i.e. by the small scale properties of the interaction, in agreement with the Chandrasekhar approach [2]. This gives a simple physical criterion for a basic distinction between long-range ($a<d$) and short range ($a>d$) interactions, different from the thermodynamic one ($a<d-1$ or $a>d-1$). This alternative classification, based purely on dynamical arguments, is relevant notably to understanding the conditions for the existence of so-called quasi-stationary states in long-range interacting systems.

[1] A. Gabrielli et al., arxiv.org/abs/1408.0999, to appear in PRE (2014)
[2] A. Gabrielli et al., PRL, **115**, 210602 (2010)

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