北京理工大学

数学与统计学院学术报告

Propagation of chaos for the Landau equation via microcanonical binary collisions

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摘要：

We develop a fully constructive, conservative, and collision-level realization of Kac's program for the spatially homogeneous Landau equation across the full interaction range, including the Coulomb case. Our model is the microcanonical binary-collision (MBC) process: a reversible pure-jump N-particle Markov process that is Landau-native, realizing the grazing-collision mechanism via small conservative rotations of relative velocities. The analysis hinges on two critical structural pillars: a Fisher-information dissipation mechanism that extends the Guill\'en--Silvestre paradigm (Acta Math. 234:315--375, 2025) to a genuinely conservative particle system, yielding robust control of singular configurations, and a quantitative self-averaging principle that enforces a coherent deterministic emergence of the Landau flow from the microscopic dynamics. We prove propagation of chaos in the joint mean-field and grazing-collision limit ($N\to\infty, h\to 0$), identifying any limit point with the unique global solution to the Landau equation. Furthermore, we rigorously derive the Landau master equation as the grazing-collision limit of the MBC process. To the best of our knowledge, this provides the first fully conservative, Landau-native binary-collision model rigorously shown to produce the Landau equation over the entire interaction range.

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