A KINETIC MODEL OF FRICTION IN STRONGLY COUPLED STRONGLY MAGNETIZED PLASMAS

L. Jose, S. D. Baalrud

University of Michigan, Nuclear Engineering and Radiological Sciences, Ann Arbor, Michigan, United States of America

Novel transport properties exhibited by plasmas that are strongly magnetized in the sense that the gyrofrequency exceeds the plasma frequency are not well understood. Recent works studying weakly coupled plasmas have shown that strong magnetization leads to a transverse component of the friction force that is perpendicular to both the Lorentz force and velocity of the test charge; in addition to the stopping power component. Recent molecular dynamics simulations have also shown that strong Coulomb coupling in addition to strong magnetization gives rise to a third ‘gyrofriction’ component of the friction force in the direction of the Lorentz force. Here, we compute the friction force acting on a massive test charge moving through a strongly coupled and strongly magnetized one-component plasma using a generalized Boltzmann kinetic theory. The theory captures these effects and generally agrees well with the molecular dynamics simulations over a broad range of magnetization strength and Coulomb coupling regimes. Furthermore, the strong magnetization breaks a fundamental symmetry in traditional plasma theories: The friction force is dependent on the sign of colliding particles. This effect is known as the Barkas effect, and it reduces the stopping power and enhances the transverse and the gyrofriction components.

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