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Friction Force in Strongly Magnetized Plasmas[1]

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The friction force on a single particle moving through a plasma is conventionally thought to act anti-parallel to its velocity. However, recent work predicts that it has an additional component perpendicular to the velocity vector and the Lorentz force vector when the plasma is strongly magnetized, i.e. when the gyro-frequency exceeds the plasma frequency [1]. This transverse force is predicted to significantly alter the trajectory of the projectile particle [1]. This presentation shows results of first-principles molecular dynamics simulations that confirm the existence of the predicted transverse force. A transverse force is observed when the projectile's velocity is at an oblique angle with respect to the magnetic field. A predicted asymmetry in the electrostatic potential wake about the projectile that causes the transverse force is also observed. This effect is predicted to influence transport properties in many applications in which strongly magnetized plasmas are found, including non-neutral plasmas, ultra-cold plasmas, antimatter traps, and fusion experiments. For example, in antimatter traps the transverse force may influence the dynamics of injected anti-protons as they cool by slowing on strongly magnetized electrons. In this application, plasmas can be both strongly magnetized and strongly coupled, i.e. when the average inter-particle potential energy exceeds the average thermal energy. The combined influence of strong coupling and strong magnetization on the transverse force is also quantified, and the results show that the transverse component becomes a larger fraction of the total friction force when the plasma is strongly coupled. [1] - T. Lafleur and S. D. Baalrud, Plasma Phys. Control. Fusion 61 125004 (2019).

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