Suppressed momentum and heat transport in magnetised astrophysical and laser-fusion plasmas

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The magnetised, weakly collisional plasmas that are typically found in astrophysical environments and laser-plasma experiments are quite unlike the plasmas and gases encountered in terrestrial contexts. The microphysics of these plasmas is more complicated than that in gases because, in addition to inter-particle collisions, the plasma's constituent particles interact with electromagnetic fluctuations that are generated by plasma microinstabilities driven by gradients in macroscopic plasma parameters (e.g., temperature or bulk fluid velocity). Both astrophysical observations and recent laser-plasma experiments suggest that classical models of their material properties, which overlook this difference, can give rise to significant overestimates of both the plasma's heat conductivity and viscosity. In this talk, I will illustrate the general tendency of weakly collisional plasmas, whose thermal energy greatly exceeds their magnetic energy — viz., plasmas with a large plasma beta — to have suppressed transport properties compared to classical models. A novel numerical method for calculating transport that arises from macroscopic gradients in such plasmas, which overcomes limitations of previous research on this problem, will be presented, as will ongoing efforts to test these revised models with bespoke laser-plasma experiments. Finally, the implications of suppressed transport models for inertial-confinement-fusion experiments and the macroscopic dynamics of the intracluster medium of galaxy clusters will be discussed.