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Signatures of turbulent magnetic fields in merging galaxy clusters

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Kelvin-Helmholtz Instabilities (KHI) along contact discontinuities in galaxy clusters have been used to constrain the strength of magnetic fields in galaxy clusters, following the assumption that, as magnetic field lines drape around the interface between the cold and hot phases, their magnetic tension resists the growth of perturbations. This has been observed in simulations of rigid objects moving through magnetised media and sloshing galaxy clusters, and then applied in interpreting observations of merger cold fronts. Using a suite of MHD simulations of binary cluster mergers, we show that even magnetic field strengths stronger than yet observed ($\beta = P_{\rm th}/P_B = 50$) show visible KHI features. This is because our initial magnetic field is tangled, producing Alfven waves and associated velocity fluctuations in the ICM; stronger initial fields seed larger fluctuations, so that even a reduced growth rate due to magnetic tension produces a significant KHI eddies. The net result is that a stronger initial magnetic field produces more dramatic fluctuations in surface brightness and temperature, not the other way around. We show that this is difficult to distinguish from the evolution of turbulent perturbations of the same initial magnitude. In order to use observations of KHI in the ICM to infer magnetic field strengths by comparing to idealized simulations, the perturbations which seed the KHI must be well-understood and (if possible) carefully controlled. Since the turbulent simulations are resolution-dependent, I will also present preliminary work on modeling sub-grid turbulence in the ICM.

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