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Weibel instability in colliding electron-positron-ion plasmas

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The new regimes accessed in ultra intense laser plasma interactions and recent developments in relativistic astrophysics are giving rise to an increased interest in the Weibel instability. In fact, whenever colliding streams of plasmas (arbitrary mixtures of electrons-positrons-ions) are present, a fraction of the kinetic energy of the plasma flows can be converted to a sub-equipartition magnetic field. In this talk, and using a combination of particle-in-cell simulations and relativistic kinetic theory, I will first describe the recent theoretical advances in our understanding of the Weibel instability and the connection with the electromagnetic beam plasma instability. Emphasis will be given to the coupling with longitudinal modes, leading to the formation of tilted filaments, and to the effects of the collisions and the merging of the Weibel instability with the resistive filamentation instability. In light of these results, the relevance of Weibel instability to ultra intense laser matter interactions (e.g. fast ignition) and to astrophysical scenarios (e.g. in gamma ray bursters and for cluster magnetic fields) will be discussed. Finally, the role of the Weibel instability in the formation of relativistic shocks and in particle acceleration in these structures will also be addressed.