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Merger of super-Alfvenic current filaments during collisionless Weibel instability of relativistic electron beams[1]

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The Weibel instability (WI) is one of the most basic and long-studied collective plasma processes. The dynamics and energetics of its nonlinear saturation is important for both laboratory and astrophysical plasmas. The WI is likely to play an important role in the Fast Ignitor scenario because it can result in the collective energy loss of a relativistic electron beam in both coronal and core plasma regions. Collisionless WI has been suggested as an important mechanism for relativistic collisionless shock formation in gamma ray bursts. This talk will focus on the strongly nonlinear long-term stage of the instability, during which the beam density of filaments is compressed to the background plasma density, and the ambient plasma is fully evacuated. Analytic and numerical results demonstrate that the beam filaments can carry super-Alfvenic currents by assuming current and density profiles similar to the Hammer-Rostoker equilibrium. This has profound implications for the long-term evolution of the magnetic field and beam current and explains the long-standing puzzle: why magnetic field energy initially increases, but eventually decreases during the collisionless WI. Novel numerical and analytic tools will be described that enable computationally efficient modeling of collective beam filamentation in both collisionless and collisional ambient plasmas. [1] O. Polomarov, A. Sefkow, I. Kaganovich, and G. Shvets, Phys. Plasmas 14, 043103 (2007); O. Polomarov, I. Kaganovich, and G. Shvets, "Merger of super-Alfvenic current filaments during collisionless Weibel instability of relativistic electron beams," submitted to PRL (2008).

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