Stability analysis of a periodic system of relativistic current filaments

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Homogeneous counterstreaming plasmas are subject to the Weibel-type current filamentation instability. The subsequent evolution of the resulting magnetically pinched filaments is a topic of prime interest in astrophysics where it is believed to account for the magnetic turbulence generation in Weibel-mediated collisionless shocks [1]. It also plays an important role in high-intensity laser-plasma interactions in controling the angular spread of the laser-accelerated particles [2].

In this presentation, we perform a linear stability analysis of a periodic system of relativistic current filaments. Applying the Floquet theory to a relativistic four-fluid model, we compute the exact eigenmodes of the system, and demonstrate that the dominant modes transit from coalescence-type to kink-type instabilities with increasing nonlinearity and asymmetry between the plasma streams. Our theoretical predictions are supported by particle-in-cell simulations. In a strongly nonlinear symmetric configuration, the stationary state consists of a chain of Harris-type current sheets, for which we derive a new analytic expression for the relativistic kink instability. This formula closely matches the numerical results, and allows us to delimit the coalescence and kink-dominated parameter regions.

References

[1] M. Milosavljevic and E. Nakar, Astrophys. J. **641**, 978 (2006)

[2] A. Debayle, J.J. Honrubia, E. d’Humières and V.T. Tikhonchuk, Phys. Rev. E **82**, 036405 (2010)