Kinetic Theory of Oblique Collisionless Tearing Instabilities

SCOTT BAALRUD, AMITAVA BHATTACHARJEE, University of New Hampshire — Recent 3D PIC and linear Vlasov-Maxwell simulations [1] have shown that conventional kinetic tearing mode theory [2] vastly overestimates the growth rate of oblique modes, i.e., those with nonzero $\phi = \arctan(k_z/k_y)$ where $k_z$ is the wavenumber in the guide field direction and $k_y$ is the wavenumber perpendicular to this in the plane of the current sheet. Thus, doubts have been cast on the validity of asymptotic boundary-layer analysis in collisionless kinetic theory. We show that this disagreement is a consequence of a strong guide field assumption made in conventional theories. We relax this assumption and obtain a dispersion relation that accounts for oblique angles. Focusing on a Harris equilibrium, Ref. 1 discusses modifications in the ideal MHD region outside the $\mathbf{k} \cdot \mathbf{B}_o = 0$ surface [1]. Here we complete the necessary modifications by correcting the inner layer solution. These show that obliquity has a stabilizing effect in all but the strongest guide field cases. Our theoretical predictions are compared to the previous simulation results. [1] W. Daughton et al., Nature Phys. 7, 539 (2011). [2] J. Drake and Y. C. Lee, Phys. Fluids 20, 1341 (1977).

Work supported by appointment to the US DOE Fusion Energy Postdoctoral Research Program administered by the Oak Ridge Institute for Science and Education and DOE Grant No. DE-FG02-07ER46372.

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Date submitted: 08 Jul 2011

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