Linear Vlasov-Maxwell stability using Hermite polynomial expansion

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We present a new approach for solving the linearized Vlasov-Maxwell set of equations. The defining characteristic of the new approach is that the perturbed distribution function is described as an infinite series of orthogonal functions, chosen as Hermite-Grad polynomials. This technique is based on profound and robust theory but results in an easy implementation that avoids integration over the unperturbed trajectories and can be applied to any equilibrium. A major advantage of the approach is the direct physical meaning of the low-order coefficients is clear. The stability of an initial Harris current sheet is studied, focusing on several instabilities (LHDI, DKI, tearing), and comparing the results with particle-in-cell simulations and with a code which solves the Vlasov-Maxwell equations by means of the method of characteristics [1]. While in practice the series need to be truncated and the contribution from higher order terms has to be neglected, the accuracy of the solution, which depends on the number of terms taken in account in the Hermite series, is merely a problem of computational power. Furthermore, the code can be used to address the issue of linear stability of more realistic current equilibria proposed theoretically [2] or observed experimentally.

[1] W. Daughton, Phys. Plasmas 6 (4), 1329 (1999).
[2] E. Camporeale, G. Lapenta, J. Geophys. Res., Vol. 110, No. A7, A07206, 10.1029/2004JA010779, 2005.