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An asymptotic preserving scheme for the Vlasov-Maxwell system in the classical limit

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Abstract content
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In order to model non-thermalized plasmas in the fully magnetized and relativistic regime, the relativistic Vlasov-Maxwell (RVM) system is most commonly used. In that context efficient numerical methods have been developed (see, e.g., [1] and [2]). The dimensionless parameter c that determines the relative strength of relativistic effects is the speed of light scaled by the thermal velocity. In some applications, however, the weakly relativistic regime (i.e. where c is large) is of interest. In this case numerical simulations show that the methods that have been developed for the RVM system are extremely inefficient. In addition, many numerical methods are not even able to recover the correct limit behavior (i.e. convergence to the Vlasov-Poisson system).

In this presentation we describe the asymptotic preserving scheme introduced in [3]. This method is robust with respect to the classic limit and imposes no step size restriction. Our approach relies on a time splitting approach for the RVM system and employs an implicit integrator for the linear part of Maxwell's equations. It turns out that the choice of this implicit method is crucial as even L-stable methods can introduce numerical instabilities for large values of c.

To illustrate the efficiency of the numerical scheme in both the relativistic as well as in the classical limit regime we present the results for a number of numerical simulations. We mostly focus on the Weibel instability and on Landau damping. In the relativistic case we compare the asymptotic preserving scheme to the Hamiltonian splitting proposed in [1] and the VALIS method proposed in [2].

References

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