

A DIFFERENTIAL ALGEBRAIC HIGH-ORDER 3-D VLASOV SOLVER

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Abstract

We show how the differential algebraic methods for ODEs and the resulting high order map computation can be generalized for solving certain PDEs. The entire PDE solving problem is cast in the form of an implicit constraint satisfaction problem, which is solved via differential algebraic partial inversion methods. As a result, it is possible to describe the solutions of the PDE locally as a very high order expression in the independent variables. Because of the high orders, it is possible to choose the size of the finite elements to be large, which leads to a very favorable behavior in high dimensions. The approach can be parallelized, and as such allows the solution of complicated high-dimensional PDEs in a reasonably efficient way. Furthermore, utilizing remainder differential algebraic methods, it is possible to provide rigorous and reasonably sharp error estimates of the entire procedure. We apply the methods to the study of the Vlasov equation describing the evolution of a beam under internal and external electromagnetic fields. In the case of this particular PDE, it is possible to perform time stepping to arbitrary order with a similar ease as in the case of the corresponding map computation case. Various examples will be given to illustrate the practical behavior of the method.

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