

A new formalism for inherently robust plasma fluid simulations

F. Halpern

General Atomics, SanDiego, USA

We introduce the anti-symmetric representation of the plasma fluid model hierarchy as a path to fast, easy, and reliable simulations. In the anti-symmetric representation, the underlying symmetries of the fluid equations are exposed in such a manner that the conservation theorems have exact discrete analogs. The formalism is general and applies to the entire fluid hierarchy, including the two-fluid equations, MHD, and drift-ordered models. We demonstrate the favorable conservation properties of the formalism at each step using numerical examples. Robust numerical applications can be achieved with little effort, and conservation to machine precision is possible with simple and scalable numerical methods. The simplicity of the approach lends itself nicely for practical GPU acceleration. Exact time reversibility of the simulations, a manifestation of exact conservation, is also showcased