

PETSc-PIC: A conservative toolkit for plasma codes

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NumKin Nov 7-10 2022

Abstract

The construction of a large scale simulation code is challenging, particularly when constructing a modular solver that is easily parallelizable and robust enough to span various architectures without issue or potential redesign. It is to alleviate these challenges that we present PETSc-PIC, a collection of tools built into the PETSc library to provide plasma physics codes modular solvers which are parallelizable by construction. Among these tools are conservative implementations of the Landau collision operator in the Finite Element basis for both the CPU and GPU, the conservative particle basis Landau collision operator, electrostatic solvers which support H^1 and $H(\text{div})$ finite elements, and conservative projections between particle and finite element bases. Accuracy and performance benchmarks are also presented as the scale of verification and regression tests for these tools grow to provide a "drop in" solver where one or multiple tools may be pulled into existing codes. The toolkit may also be used as the foundation for rapid prototyping of new plasma codes leveraging PETSc's modular solvers and APIs.

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