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Solving the plasma fluid model in open source frameworks: Two-stream instability as a case study

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The plasma fluid model obtained by taking suitable moments of the Boltzmann equation represents an important tool in the study of basic plasma phenomenon. While analytical solutions of the plasma fluid model do exist for certain problems, numerical solutions are required for most problems of interest. This tutorial will focus on the utility of open source computational frameworks for solving the plasma fluid model with specific emphasis on the OpenFOAM C++ library for solving partial differential equations using the finite volume method. After a brief introduction to the library, the tutorial will provide a hands-on demonstration of developing a module to solve the plasma fluid model and applying it to the two-stream instability problem. The numerical solutions obtained from the OpenFOAM plasma fluid model will be compared with results obtained from analytical and kinetic methods. The tutorial will conclude with a quick overview of other modules developed in the OpenFOAM framework that are relevant to plasma science and engineering. This tutorial can be expected to provide graduate students and other researchers with the fundamental knowledge to develop their own generic plasma code in existing open source frameworks.