Plasma Two Ways: Foundations of Kinetic and Fluid Models of Plasma, a Tutorial

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This tutorial will present a pedagogical introduction to plasma kinetic and fluid equations, emphasizing theoretical foundations for the two common plasma models, as well as their numerical solution; particularly particle-in-cell and two-fluid. The intended audience is graduate students, as well as colleagues who work on more applied topics or who are changing areas of research and who seek an introduction to the foundations of plasma model equations, the physical processes included and excluded from different approximations, and numerical methods used to solve these equations. In order to focus on a definitive example, each of the theoretical models and numerical solution techniques will be applied to an experimentally-motivated problem of streaming instabilities in the plasma-boundary transition region. The theory will be broadly applicable, but the example chosen to illustrate distinguishing features of kinetic and fluid models.