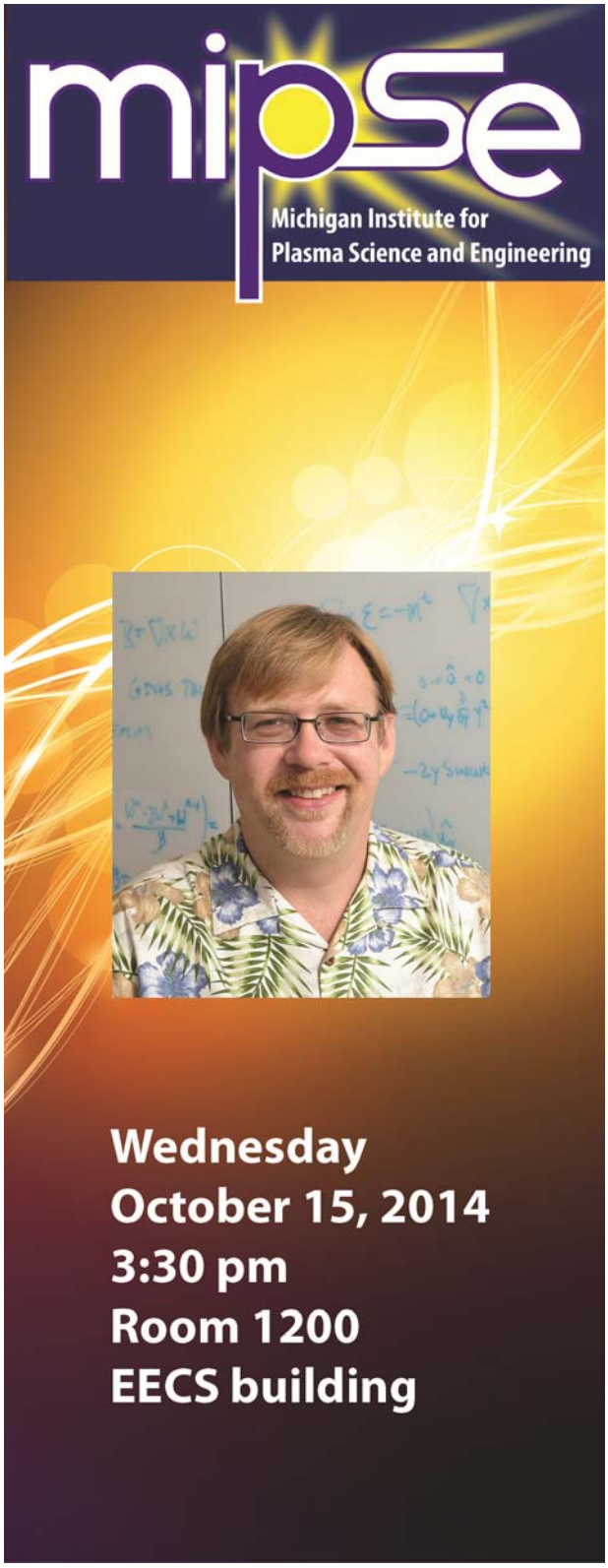

Prof. Andrew Christlieb
Michigan State University

The Role of Benchmark Tests Problems and Developing High Order Kinetic Methods

In this talk, we review the topic of Validation and Verification of Plasma Kinetic Codes, the subject of a series of ongoing workshops. The goal of the workshops is to highlight the need to develop benchmark test problems beyond traditional problems such as Landau damping and the two stream instability. These test problems provide a limited understanding of how a code might perform and mask key issues that show up in more complicated situations. Developing test problems that highlight the strengths and weaknesses of both mesh- and particle-based codes is a critical need. Designing test problems that clearly deliver a path forward for developing improved methods is complicated by the need to thoroughly develop a completely self-consistent model. As an example, we introduce new spectral semi-Lagrangian and discontinuous-Galekin (DG) based Eulerian in space and semi-Lagrangian in velocity methods, and ask what benefits resulted in simulation of a kinetic system. We review two test cases. The first is sheath formation in a 1D-1V collisionless plasma. In this case we found that losses to the wall lead to discontinuous distribution functions, which were challenging for high order mesh based solvers. The semi-infinite case was challenging because pf the far field boundary condition in a finite domain. The second example is flow of a collisionless electron beam in a pipe. In this case, numerical diffusion is a key challenge. However, the two stream instability at the beam edges introduces other challenges in terms of finding convergent solutions. One key conclusion we draw from this exercise is that including collisional models in benchmark test problems for mesh based plasma simulation tools is an important step in providing robust test problems for mesh based kinetic solvers.

Collaborators: Yaman Guclu, David Seal John Verboncoeur

About the Speaker: Dr. Andrew Christlieb received his PhD from U. of Wisconsin-Madison in 2001. He was then a postdoc in the Aerospace Department at the U. of Michigan with Iain Boyd, working on the simulation of micro air foils, and in the Mathematics Department at UM where he worked with Robert Krasny on the development of mesh free methods for plasma simulations. In 2006 Dr. Christlieb joined Michigan State University. Since 2004 Dr. Christlieb has worked closely with the RDHE group at the Air Force Research Labs on the development of new methods for particle simulations of plasmas. In 2007 He received the Air Force Young investigator award for his work on the development of novel methods for simulating plasmas. In 2010 Dr. Christlieb was promoted to Associate Professor and in 2014 he was promoted to MSU University Foundational Professor. His group currently works on the development of high order numerical methods and sub linear lossy compression algorithms. He has developed high order Eulerian, Lagrangian and semi-Lagrangian conservative methods for the kinetic simulation of plasmas as well as high order finite difference constrained transport methods for the simulation of magnetohydrodynamics.