Kinetic Simulation of Non-Equilibrium Plasmas
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This project is on innovative methods for kinetic simulation of non-equilibrium plasmas, which are important for applications such as directed energy, remote sensing, space propulsion and space weather. When they are required for physical fidelity and accuracy, kinetic simulations can be very demanding because of the complexity of both their formulation and their solutions. The project is focused on kinetic regimes for which current simulation methods are ineffective, and new analytic and algorithmic ideas are needed.

The proposed research includes two projects: The first is Monte Carlo simulation of Collisional/Radiative (CR) kinetics and is in collaboration with Dr. Jean-Luc Cambier (AFRL/RQRS). The focus is on inelastic collisions, in particular electron impact excitation/deexcitation and ionization/recombination. These are important for production of radiation and for plasma equilibration, for example after laser heating of a plasma. The second project is identification of extreme solutions for vacuum currents. This will provide a unique benchmark for critical behavior in standard simulation methods (e.g., PIC, Vlasov), and is potentially relevant to physical features found in extreme plasma conditions. Extension to the collisional and ionizing solutions (non-vacuum), for which the first research project will prove critical for standard simulation techniques, will be examined in the future.

This research is enabled by recent mathematical advances in Monte Carlo simulation techniques and in solution methods for PDEs. This research will be performed by the PI in collaboration with a graduate student and a post-doctoral scholar. Mentoring of these junior researchers is an important part of the research effort.

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Collaborators:

- Dr. Bokai Yann, UCLA Mathematics Department
- Hai Le, UCLA MANE Department
- Dr. Jean-Luc Cambier (AFRL/RQRS)
- Dr. Mark Rosin, Pratt Institute
- Dr. Lee Ricketson, NYU