Probabilistic modelling of atomic radiation processes

Stage topic description

In many fields of space research radiation plays a crucial role, e.g. in hyperbolic, atmospheric (re-)entry manoeuvres where radiation typically represents the main contribution to the surface heating. Another example is the low wavelength radiation in certain plasma propulsion systems like high power pulsed plasma thrusters or inertial electrostatic confinement thrusters.

In the case of the mentioned re-entry flows it is known that traditional models (Boltzmann) as well as state of the art models (QSS) are not able to reproduce with certain reliability the relevant spectra seen by the re-entry body. This is due to a mismatch between radiation simulation results and the experimental references. Consequently, the prediction of the plasma radiation generated by the non-equilibrium plasma in front of the re-entry body is, reliably, not possible yet. The application of probabilistic particle methods might provide a solution to this problem.

Candidate's tasks

The successful candidate will develop a tool which computes for a given atomic excited state and individual emission probability. Given that, the approach can be extended towards a many particle system with a pre-defined distribution of excitation states such that, in the simplest case, a Boltzmann like radiation can be reproduced. Under certain assumptions this allows to study the correlation between a given radiation intensity and an unknown distribution of the particle’s energy states. In detail, the successful candidate will have the following tasks:

- Development of a probabilistic model for spontaneous emission in atoms;
- Reproduction of equilibrium radiation spectra on basis of multi-particle simulations;
- Implementation of an algorithm for the initialization of arbitrary excitation states;
- Investigation of the correlation between radiation intensity and distribution of excitation states via genetic algorithms.

The ideal candidate

The student should have good knowledge of plasma physics and classical mechanics. Also, knowledge of Matlab and/or Fortran is an asset.