Karlsruher Institut für Technologie

Scientific Computing Center

Structure-Preserving Operator Learning for the Landau equation

Target group

B.Sc. or M.Sc. Mathematics

Description of the topic

This topic investigates the capability of the Deep Operator network (DeepONet) approach to model the high dimensional collision operator in kinetic theory. Specifically, we consider the Landau equation, which describes the evolution of the distribution of charged particles in a plasma undergoing grazing collisions. The Landau operator is a nonlinear integro-differential operator with essential structural properties such as conservation and entropy dissipation. Therefore, a surrogate model needs to preserve these properties to enable physically meaningful simulation.

In this thesis, we aim to develop DeepONet-based surrogate models that ensure the conservation. To be precise, we adapt the trunk network so that the DeepONet has the same collision invariants as the Landau operator.

Helpful prerequisites

Helpful prerequisites for working on this topic:

- Experience in programming
- Experience in machine learning and PDEs

Exemplary questions (current or new)

- How to generate data? This consist of sampling from the distribution functions as well as computing the Landau operator numerically.
- How well the surrogate model mimics the conservation properties?
- How to tune the model parameters to gain speedup or accuracy?

Contact

Computational Science and Mathematical Methods https://www.scc.kit.edu/forschung/csmm.php
Dr. Yijia Tang (yijia.tang@kit.edu)