# A radial basis function solution of the Vlasov equation

**Project description** Magnetic confinement fusion is a promising technology to gain a sustainable and inexhaustible source of energy. Physicists are currently interested in gaining a better understanding of the behavior of the plasma in the fusion reactor close to the boundary of the vessel. The physics in this part of the vessel is challenging and traditional models break down, triggering the need for novel modelling and approximation techniques. In particular, fully kinetic solvers are desirable in this endavor. A kinetic description of the plasma consists of an advection equation in six-dimensional phase space, non-linearly coupled to Poisson's (or Maxwell's equation) equation. This model is very challenging computationally due to its high-dimensionality combined with the multiscale nature of the problem.

Radial basis function approximation of partial differential equations are a promising alternative to more traditional approximation techniques, since they offer flexibility with respect to the geometry, yield very accurate solutions and are easily extensible to high dimensions. Recently it has been shown that radial basis functions can be very efficient in a least squares partition-of-unity ansatz (RBF-LS-PUM), that makes sure that the global basis functions are partly localized which makes the method computationally feasible.

The goal of this project is to achieve a proof-of-concept implementation of the RBF-LS-PUM method for the Vlasov equation in a simple domain and reduced phase-space starting from an implementation of the RBF-LS-PUM method for the Poisson equation.

**Work plan**

- Implementation of the domain partitioning for periodic domains.
- Implementation of RBF-LS-PUM for an advection equation in 2d.
- Implementation of RBF-LS-PUM for the Vlasov–Poisson equation in reduced two-dimensional space.
- Possible extentions if time permits: Extention to higher dimensions; anisotropic domain; open boundary conditions.

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