Spline interpolation on a multi-patch geometry with an X-point for Vlasov-type equation solved with a BSL method

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We present a backward semi-Lagrangian (BSL) method for the numerical resolution of Vlasov-type equations on multi-patch meshes. In a tokamak, the charged particles are strongly driven by the toroidal magnetic field, and slowly drifted by the poloidal magnetic field. Their motion is governed by Vlasov-type equations. In the BSL method, we follow the particle trajectory with the method of characteristics. We align the mesh lines on the flux surfaces of the toroidal magnetic field. These mesh lines separate the poloidal plane into different zones with different regimes : fast motion in the core with an O-point where the mesh lines converge ; slow motion at the edge with an X-point where they diverge. Both come with singularities in the coordinate transformation. We employ a multi-patch approach and apply a tensor-product local cubic spline interpolation with Hermite boundary conditions between the patches to represent the physical quantities. In this talk, we present the derivative reconstruction at the interfaces to cope both non-uniform and non-conforming meshes [1] and discuss methods to deal with X-point singularities. All the numerical results are obtained using the Gyselalib++ library.

Références

[1] P. Vidal, E. Bourne, V. Grandgirard, M. Mehrenberger, E. Sonnendrücker *Local cubic spline interpolation for Vlasov-type equations on a multi-patch geometry.* Journal of Scientific Computing 106(2) :58, Jan 2026.

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