Variational particle schemes for Vlasov-Maxwell equations

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Variational discretizations are known for preserving key physical invariants in a natural way, leading to long-time stability properties. In this talk I will present a discrete action principle for the Vlasov-Maxwell equations that generalizes the GEMPIC Hamiltonian particle scheme [5] and applies in a general, "structure-preserving" discrete framework [3].

In this framework the finite-dimensional electromagnetic potentials and fields are represented in a discrete de Rham sequence involving (generalized) Finite Element spaces, and the particle-field coupling is represented by a set of projection operators that commute with the differential operators [1, 4]. One key result is that any variational particle scheme derived withing this general framework is gauge independent and has a discrete Hamiltonian structure. It particular, it is energy preserving at the semi-discrete level and preserves the discrete Gauss laws.

One application of this approach is a new variational spectral PIC method that has a discrete Hamiltonian structure and relies on particle-field coupling techniques very similar to those encountered in standard PIC schemes [2].

References

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