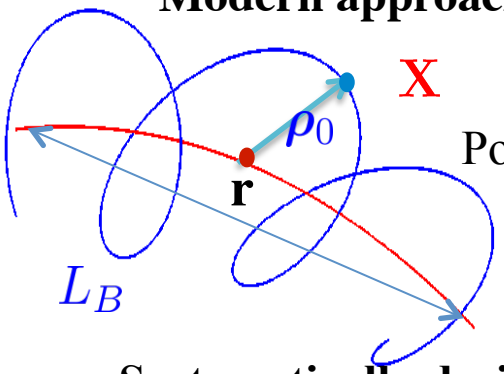
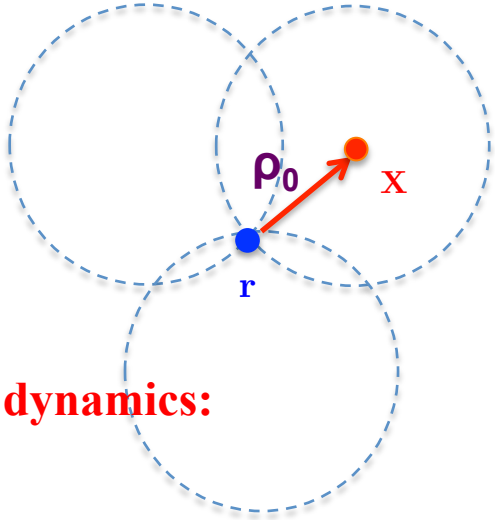
Second order Gyrokinetic Vlasov-Maxwell system PIC code and GK theory

Natalia Tronko, IPP Max Planck fûr Plasmaphysik

- **Removing fast scale of motion from particles dynamics**:
- Gain of computational time for low frequency turbulence study in fusion plasma
- **Modern approach: invertible near-identity phase space transformations**



Polarization effects due to difference between fields and reduced particles positions



- **Systematically derived analytical model:**

Reduced (GK) particles dynamics should be coupled with fields dynamics:

- Consistent orderings and good conservation properties
- Energy, Momentum & phase space volume conservation

Field theory formalism:

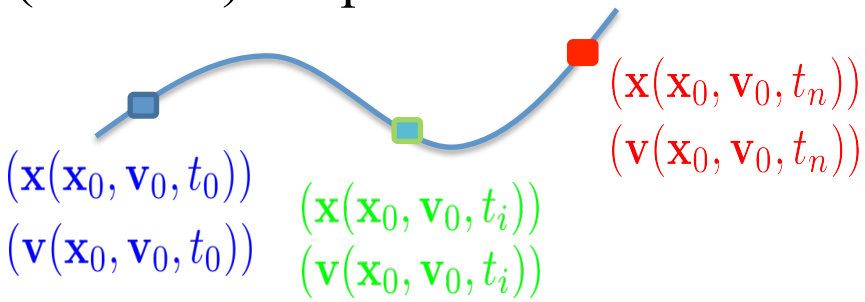
- Systematically introduced physical approximations guarantees self-consistency of the model
- Noether's method for consistently conserved quantities derivation
- **Eliminating all sources of possible inconsistencies before discretisation**

Main results : detailed comparison of both models: full second order & NEMORB physical model
Identification of inconsistences due to neglecting terms

Systematic derivation of reduced model in variational framework
two ways of field/particles coupling

PIC Code NEMORB

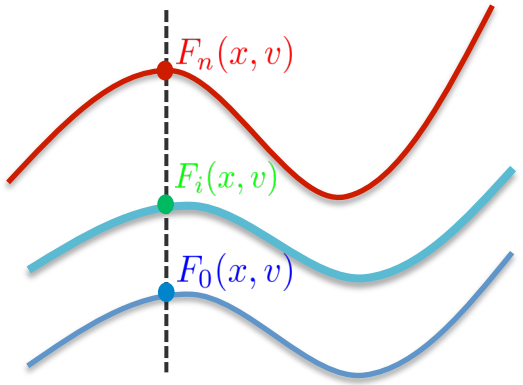
Lagrangian: dynamics of particles (markers) coupled with elm fileds



- Independent fields variations
- Reconstruction of Vlasov equation from characteristics
- Conservation laws reconstruction via Vlasov moments calculation

Eulerian GK Field theory

Eulerian: Dynamical Vlasov field coupled with elm fields



- Constrained variations
- Vlasov equation: part of variational principle
- Direct derivation of conservation laws