ACCELERATOR SEMINAR

Prof. John Cary

TechX, Boulder USA

Thursday, 11th May at 4 p.m.

lecture hall side room (south building)
Planckstraße 1, 64291 Darmstadt

"Structure Preserving Integration of Charged Particles in Electromagnetic Fields"

Time-centered, hence second-order, methods for integrating the relativistic momentum of charged particles in an electromagnetic field are derived. A new method is found by averaging the momentum before use in the magnetic rotation term, and an implementation is presented that differs from the relativistic Boris Push only in the method for calculating the Lorentz factor. This is shown to have the same second-order accuracy in time as that found by splitting the electric acceleration and magnetic rotation (Boris Push) and that found by averaging the velocity in the magnetic rotation term (Vay's method) [J.-L. Vay, Physics of Plasmas (1994-present) 15, 056701 (2008)]. All three methods are shown to conserve energy when there is no electric field. The Boris Push and the current method are shown to be volume-preserving, while Vay's method and the current method preserve the $\exb$ velocity. Thus, of these second-order relativistic momentum integrations, only the integrator introduced here both preserves volume and gives the correct $\exb$ velocity. While all methods have error that is second-order in time, they deviate from each other by terms that increase as the motion becomes relativistic. Numerical results show that Vay's method develops energy errors near resonant orbits of a test problem that neither volume-preserving integrator does.

GSI Organizers: Dr. Giuliano Franchetti, Dr. Jens Stadlmann FAIR