Simulating a fusion reactor with GORILLA

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After an introduction to fusion energy and magnetic confinement, this talk presents GORILLA (Guiding-center ORbit Integrator with Local Linearisation Approach), a code for computing the motion of charged particles in fusion devices. Averaging over the fast gyration of particles around magnetic field lines leads to the guiding-center description, in which a non-canonical phase-space Lagrangian reduces the dynamics from six to four dimensions.

Instead of approximately solving the exact equations of motion, GORILLA solves approximate equations exactly: the electromagnetic fields are linearised on a tetrahedral mesh, so that inside each tetrahedron the equations of motion become linear ODEs with constant coefficients. Orbits are passed from cell to cell via exit times given by polynomial roots, which makes the code fast and allows distribution functions to be computed on the fly.

Since the resulting Hamiltonian is only piecewise smooth, symplecticity of the flow is not automatic, and the extent to which it holds is discussed. Finally, two extensions are sketched: collisions modelled as diffusion in velocity space, and the self-consistent computation of electric fields.