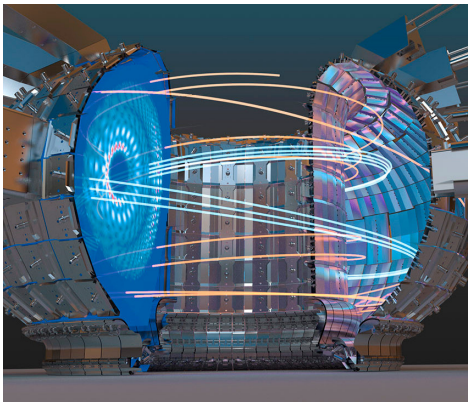
Simulation of charged particle orbits in fusion plasmas TIFX02-15-41



Background: How we produce our electricity, is the question of the century. If the polluting emissions from fossil fuels are to be cut down, new clean and safe energy sources are needed. If successful, thermonuclear fusion would provide such a source. To make it work, a massive international experiment to demonstrate the possibility of commercially produced fusion energy, the ITER reactor, is currently being built in Cadarache, southern France. Before the reactor starts its operation modeling work is needed to verify proper operation parameters.

Problem description: Highly energetic charged particles have an important role in fusion plasmas. In ITER, the energetic fusion-born alpha particles will heat the plasma, and help to sustain the plasma temperature. High energy electrons, on the contrary, may cause severe damage to the machine, if not properly treated. Modeling the behaviour of these particles is needed to secure the confinement of the alpha particles within the plasma to provide heat, and to make sure the high energy electrons do not damage the machine. Particle tracing in the plasma is thus needed.

Methodology: The students are introduced to the field by a literature survey and hand-to-hand teaching: Lagrangian and Hamiltonian mechanics play a crucial role in particle tracing. Students will also be introduced to phase-space perturbation methods that allow time-scale reduction techniques. After understanding the essentials of the charged particle motion in electromagnetic fields, the students will write their own code for following particle trajectories.
Group size: 3 students.

Target audience: F, GU-physics.
Interest in numerical and analytical methods.

Literature:
Francis F. Chen, An Indispensable Truth; How Fusion Power Can Save the Planet (e-book, exists in Chalmers library).
V. I. Arnold, Mathematical Methods of Classical Mechanics 2nd ed. Springer Verlag 1989

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