PARTICLE ORBIT FOLLOWING IN A STELLARATOR FUSION REACTOR

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The stellarator is one of the most novel ideas in the world of magnetic confinement fusion. It is an alternative to the more popular tokamak concept, having preceded it and coexisted throughout the history of fusion. The stellarator does not have the toroidal symmetry and current drive of tokamaks, instead relying on a complex magnetic field alone for confining the plasma. This has important benefits: the main obstacle between a tokamak reactor and a fusion power plant is that tokamaks, being based on transformer principle, are inherently pulsed devices. In stellarators the desired magnetic 'cage' is built without the transformer action, and thus they are capable of continuous operation. This makes stellarators very attractive for power production.

The stellarator concept is being tested around the world, with the goal of providing an alternative route to fusion energy. This has lead to the building of the advanced Wendelstein 7-X stellarator (W7-X) in Germany, a project which aims to demonstrate the feasibility of the stellarator concept for a fusion power plant.

One of the main disadvantages of stellarators is the difficulty of achieving confined particle orbits. This is especially problematic for fast ions, such as those produced by plasma heating or fusion reactions. Because of this, demonstrating good confinement of fast ions in stellarators is an important goal of W7-X.

In this contribution, we present a method for simulating minority particle orbits in stellarators. In particular, we focus on the energetic particles produced by a neutral beam injection (NBI) heating system. The simulations are performed using a realistic model of the W7-X reactor, and are timely for the commissioning of the NBI device in the next operating phase. The simulations are performed using the ASCOT suite of codes [1], namely the Monte Carlo orbit-following program ASCOT4 and the NBI ionization code BBNBI. ASCOT has previously been used mainly for tokamak reactors, but as an inherently non-axisymmetric code it is suitable for stellarators as well.

[1] E. Hirvijoki, O. Asunta, T. Koskela, T. Kurki-Suonio, J. Miettunen, S. Sipilä, A. Snicker, S. Äkäslompolo, *Computer Physics Communications* 185 (2014) 1310-1321.