4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Particle orbits in magnetic fields with discontinuities

Dean Muir[1], Zhisong Qu[1], David Pfefferlé[2], Matthew Hole[1], Markus Hegland[1]
[1] Mathematical Sciences Institute, Australian National University, [2]Faculty of Engineering and Mathematical Sciences, Mathematics and Statistics, University of Western Australia
e-mail (speaker): dean.muir@anu.edu.au

The Stepped Pressure Equilibrium Code (SPEC) [1] is used to find equilibrium solutions for the Multiple Region Relaxed MHD model [2].
In this, plasma is modelled as a set of nested annular toroidal volumes separated by sharp interfaces. Solving particle orbits in SPEC equilibria is more complicated than in most equilibrium codes since the orbit code must be able to account for the radial discontinuity in the magnetic field.

The particle orbit code VENUS-LEVIS [3] uses a fourth order Runge-Kutta method to solve particle orbits in a range of plasma equilibrium codes such as VMEC. We have extended the VENUS-LEVIS code to allow for particle orbits in SPEC equilibria. This 'SPEC-LEVIS' adaptation uses a continuous extension to the RK4 integrator and use a root-finder to accurately locate and advance to the interfaces. In doing so, we can maintain the numerical accuracy of a simulation across sharp boundaries between magnetic field regions. We demonstrate a VENUS-LEVIS particle orbit in a SPEC stellarator equilibrium with magnetic islands in Figure 1.

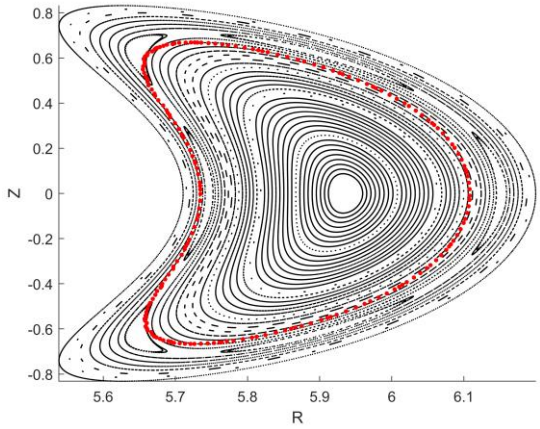

Figure 1. Stellarator Poincaré section generated by SPEC with intersecting particle orbit computed with LEVIS marked with red points.

[1] S. Hudson, R. Dewar, G. Dennis, M. Hole, M. McGann, G. von Nessi, and S. Lazerson, Phys. Plasmas 19, 112502 (2012).
[2] M. Hole, S. Hudson, and R. Dewar, J. Plasma Phys. 72, 1167 (2006).
[3] D. Pfefferlé, Ph.D. dissertation, École Polytechnique fédérale de Lausanne (2015).