MHD equilibria with magnetic islands in TJ-II using SIESTA

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Experiments in the TJ-II heliac show a correlation between the position of magnetic rational surfaces and a modification of the electron temperature profile [1], measured using Electron Cyclotron Emission (ECE) in low density Electron Cyclotron Resonance heated discharges. On plasma discharges heated using Neutral Beam Injection, ECE cannot be used due to the high density; however, using the heliac's flexibility, different rational surfaces can be swept along the minor radius by varying the helical current and it was found that the transport was reduced at the position of the rational surfaces. Bolometry studies have also shown a correlation between transport barriers appearing on rational surfaces and MHD activity [2]. This may also lead to transitions of the L-H type. These observations suggest that the plasma confinement can be improved by strategically placing rational surfaces, which in in turn give rise to a transport barrier. Since magnetic islands are likely to form at rational surfaces because the magnetic perturbations are resonant there, investigation of the presence of magnetic islands is quite interesting in the context of confinement improvement.

Using SIESTA code we calculated MHD equilibria with magnetic islands in TJ-II to determine the properties of the islands. The starting equilibrium state is the one obtained by the VMEC code with nested magnetic surfaces. Standard computations use the heliac's toroidal periodicity of 4 periods to reduce the code runtime, but this, when used in SIESTA, limits the toroidal periodicity of the islands to multiples of 4. To solve this limitation we tailored the input parameters to run VMEC without 4-period symmetry. In this way, running SIESTA with those equilibria, magnetic islands of any periodicity are obtained, including those resonant at $\iota = 3/2$ whose magnetic islands were previously absent from the simulations. The results also show 2D pressure profiles that match the location of the magnetic islands observed in the Poincaré plots of the field lines.

References

[1] D. López-Bruna et al., Plasma Phys. Control. Fusion **53**, 124022 (2011)

[2] D. López-Bruna et al., Nuclear Fusion **53**, 073051 (2013)