Verification of the SPEC code in stellarator geometries

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We present the first fixed-boundary stellarator equilibrium calculations performed with the SPEC code [1]. These equilibria correspond to minimum energy states of the *multiregion relaxed MHD* energy functional and consist of N relaxed nested volumes separated by ideal interfaces. For $N = 1$, the equilibrium reduces to a Taylor state; and ideal MHD is retrieved for $N \to \infty$ [2]. This class of equilibria can simultaneously describe magnetic surfaces, current sheets, and magnetic islands, but so far has only been verified in slightly perturbed geometries [3, 4, 5].

First, an $l = 2$ stellarator field is considered as a testbed in which to perform careful verification calculations against corresponding Biot-Savart solutions for the vacuum field. The boundary surface provided to SPEC as input is generated from field-line-tracing of the magnetic field obtained from Biot-Savart. The corresponding vacuum solution from SPEC is obtained for $N = 1$ and zero parallel current. Careful convergence studies are presented. Finally, the verification procedure is repeated for Wendelstein 7-X geometry in experimentally relevant vacuum configurations, including the island chains expected at the edge.

References

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