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Three-dimensional Beltrami states for toroidal, shaped plasmas

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Three-dimensional force-free states describing toroidal plasmas with D-shaped cross section, are constructed. The construction is carried out by perturbing two-dimensional axisymmetric single-Beltrami states with translationally symmetric ones. The perturbation and the unperturbed magnetic field have a common Beltrami parameter λ , thus their superposition still satisfies the Beltrami equation. The boundary was imposed on the axisymmetric state upon using proper conditions for specific boundary points according to the shaping method. The addition of the translationally symmetric component as a small perturbation has a noticeable impact on the equilibrium state, i.e. one can observe helical magnetic islands in Poincaré maps, which appear in certain rational magnetic surfaces. Furthermore, the conjecture of previous work is confirmed, according to which the surfaces of the resulting 3D configuration remain closed (toroidal) in the vicinity of the magnetic axis if the axisymmetric field has sufficiently high weight in the superposition.

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