Pfefferlé, D.; **Cooper, W. A.**; **Graves, J. P.**; **Misev, C.**

VENUS-LEVIS and its spline-Fourier interpolation of 3D toroidal magnetic field representation for guiding-centre and full-orbit simulations of charged energetic particles. (English)

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Summary: Curvilinear guiding-centre drift and full-orbit equations of motion are presented as implemented in the VENUS-LEVIS code. A dedicated interpolation scheme based on Fourier reconstruction in the toroidal and poloidal directions and cubic spline in the radial direction of flux coordinate systems is detailed. This interpolation method exactly preserves the order of the RK4 integrating scheme which is crucial for the investigation of fast particle trajectories in 3D magnetic structures such as helical saturated tokamak plasma states, stellarator geometry and resonant magnetic perturbations (RMP). The initialisation of particles with respect to the guiding-centre is discussed. Two approaches to implement RMPs in orbit simulations are presented, one where the vacuum field is added to the 2D equilibrium, creating islands and stochastic regions, the other considering 3D nested flux-surfaces equilibrium including the RMPs.

MSC:

82-08 Computational methods (statistical mechanics) (MSC2010)
65D05 Numerical interpolation
65D07 Numerical computation using splines
65D30 Numerical integration
82C70 Transport processes in time-dependent statistical mechanics
82D10 Statistical mechanics of plasmas

Keywords:

orbit simulations; magnetic equilibrium representation; fast ion transport; Tokamak plasmas; curvilinear coordinates

Software:

VENUS-LEVIS

Full Text: DOI

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