Advanced numeric methods for plasma turbulence simulations in the edge of a tokamak

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ABSTRACT

The analysis of turbulent transport in a tokamak is very important for several reasons. Indeed, the operation of a tokamak is based on the confinement of particles and energy, along closed magnetic surfaces. However, even in a very strong magnetic field, we observe experimentally a transport of charged particles and heat across magnetic surfaces. This transport, called anomalous, is generally associated with a small scale turbulence and it's particularly important in the plasma edge: we speak about plasma loss of confinement by turbulent transport. Due to this, plasma can interact with the vacuum chamber, producing impurities that can be advected into the core by the turbulent plasma velocity field. Impurities have a strong influence on the tokamak performance, cooling the plasma by radiation when penetrate into the core, and contributing in the erosion and deposition phenomena when impact the wall. The comprehension of turbulent transport is therefore a key element for the performance and security of fusion devices.

Nowadays, one way to predict the turbulent transport patterns under several operation conditions in future reactors uses numeric simulation of turbulent plasma flow. The main objective of this work, is the implementation and testing of different approaches to solve the parallel magnetic line diffusion operator, including aligned [1] and support operator approaches [2] in straight and curvilinear field lines. On one hand, the accuracy of these methods are directly related with the interpolation techniques and the grid resolution in the interpolation direction, because of strong gradients founded in the perpendicular magnetic field direction. Due to this, filtering techniques will be presented taking advantage of this physical property at the interpolation step, increasing the accuracy of the whole discretization. On the other hand, to ensure the numerical stability of the solving method, invertible sparse matrices are required, and the computational cost must be minimized.

REFERENCES

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