Particle diffusion and density flux in strong drift-wave turbulence containing vortical structures (poster)

Naulin, V.; Basu, R.; Jessen, T.; Michelsen, Poul; Nielsen, A.H.; Juul Rasmussen, J.

Published in:
Book of abstracts

Publication date:
2001

Document Version
Publisher's PDF, also known as Version of record

Particle diffusion and density flux in strong drift-wave turbulence containing vortical structures

V. Naulin, R. Basu, Th. Jessen, P. Michelsen A. H. Nielsen, and J. Juul Rasmussen

Optics and Fluid Dynamics Department

Association EURATOM-Risø National Laboratory

Risø, DK-4000 Roskilde, Denmark

Energy and particle transport across magnetic field lines in tokamaks and stellarators, known as anomalous transport, are generally agreed to be due to low-frequency, electrostatic turbulence whose dominating velocity is the $E \times B$-drift. A good candidate to understand and explain this phenomenon from first principles is drift-wave turbulence.
In this contribution the diffusion of ideal test particles in electrostatic drift-wave turbulence is investigated numerically. A Hasegawa-Wakatani type model is used to obtain the 2D turbulent flow-field with a self consistent instability drive. Earlier studies of test particle diffusion have worked with generalized models for the time dependence of a synthetic turbulent flow field, which exclude non-linear effects like mode coupling and the build-up of correlations. It is shown that nonlinear couplings lead to the formation of transient coherent vortical structures in the flow. By distinguishing between particles trapped in these structures and free particles we derive conditional diffusion coefficients.
We demonstrate, that the trapping of particles in and subsequent displacement with the nonlinear vortex structures leads to an anomalous diffusion. The reason for this is that the vortices have finite average velocities in the poloidal as well as in the radial (background density gradient) direction.
The vortical structures are also found to have a strong influence on the turbulent flux $\vec{\Gamma} = n\, \vec{v}_{E\times B}$. In particular they give rise to strong bursts in the flux $\vec{\Gamma}$.
Furthermore, we have shown that the average flux $\langle\vec{\Gamma}\rangle$ is well described by the flux obtained by using the diffusion coefficient obtained from the dispersion of ideal particles and Fick's law.