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Relation of plasma flow structures to particle tracer orbits

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Turbulence induced transport is one of the outstanding physics problems in plasma physics. In the turbulence induced transport issue, we began with the identification of turbulent flow structures using topological and geometric techniques on the framework of resistive MHD. The structure of the flow is filamentary. The filaments are vortices that are linked to the rational surfaces. At a given time some filamentary vortices located at the lowest rational surfaces close on themselves forming toroidal knots, we characterize them by the time they remain close loops, that is their life. Other filaments are broken and we characterize them by their length. In the case that an averaged poloidal flow is self-consistently included in the calculation, there are some new structures associated with the transport barriers created by the shear in the mean flow.
Now, we want to relate these topological structures to properties of tracer particles within a framework of the continuous random walk (CTRW) approach. Vortices may cause some of the trapping of particles, while large scale flows may carry them from vortex to vortex. We focus on the relation between the trapping times and lifetimes of the flow structures and other detrapping mechanisms. The results indicate that most of the trappings that are completed during the calculation correspond to tracers trapped on broken filaments, including possible multiple trappings. The probability distribution function of the trapping times is then a function of the filament length, and has a lognormal character, like the distribution of filament lengths. In the case that an averaged poloidal flow is self-consistently included in the calculation, there is an increase in the tracer trapping due to the transport barriers created by the shear in the mean flow. The tracers trapped in the barriers do not follow the flow filaments linked to the magnetic field lines.

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