Characterization of buoyancy-driven eddies of liquid metal MHD flows in breeding blankets

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Lead-lithium flows are promising proposals for the design of tokamak breeding blankets. Since they work under magnetic fields they are affected by magnetohydrodynamic (MHD) effects. The neutron flux originated in the tokamak heats the breeding blanket channels in a non-uniform way, inducing buoyancy to the liquid metal. This buoyancy becomes a source for eddies that increases the transport of heat and tritium through the blanket. The blankets characterized by high-speed liquid metal flows will have ceramic insulating walls that will transform the MHD flow into a quasi-two-dimensional (Q2D) flow perpendicular to the magnetic field. The use of Q2D models proposed by Sommeria and Moreau (SM82) have already been successfully used for computational fluid dynamics (CFD) simulations in our group by means of OpenFOAM, showing great agreement with benchmark cases [1]. In this work, we include a validation of the Q2D model in buoyancy-driven cases and we investigate the combination of inertia, electromagnetic and buoyant forces that promote the generation of eddies. We also show the results provided by the previously validated post-processing tool based on the bi-dimensional Fast Fourier Transform for eddy detection and characterization.

[1] Daniel Suarez *et al.* 2023 *Plasma Phys. Control. Fusion* **65** 044005