Kinematic dynamo threshold in time dependent velocity fields

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Conducting neutral fluid flows can be dramatically different from the non-conducting case because of their interaction with magnetic fields, either internal (self-sustained) or external (forcing). In this work we present an experimental analysis of a von Kármán swirling flow and the influence of this hydrodynamics in the generation of a magnetic filed.

The objective is to determine the effect of time dependent flows in the threshold of the dynamo action. To achieve this goal, we have characterized the flow before this instability in a model experiment (using water). This velocity field, determined only by the hydrodynamics, has been used to find out the MHD effects. The fluid has been stirred in a cylindrical cavity up to a Reynolds number of 10^6. We show that the average velocity field of the turbulent flow bifurcates subcritically breaking some symmetries of the problem and becomes time-dependent because of equatorial vortices moving with a precession movement. This subcriticality produces a bistable regime, with a hysteresis region for an extremely small range of parameters. Three different time-scales are relevant to the dynamics, two of them very slow compared to the impeller frequency.

We have studied the different time scales of the system, changing a enclosure volume (neutrally buoyant spheres) assuming that the density of the sphere is homogeneous. We follow this volume in a period of time and we compare the results in different spatial scales.

The effect of these different time-scales and symmetry-breaking's has been tested in a kinematic dynamo code. The threshold strongly depends on the existence of these features.