Large scale fluctuations and dynamics of the Bullard - von Karman dynamo

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The importance of turbulent induction processes in dynamo action has been recognized for most natural dynamos. More recently, the von-Kármán Sodium dynamo showed the importance of turbulent fluctuations in the generation and dynamics of the magnetic field. We will present and analyze the features of an experimental synthetic fluid dynamo built in the spirit of the Bullard dynamo. It is a two-step dynamo in which one process stems from the fluid turbulence, while the other part is achieved by a linear amplification of currents in external coils, as in the Bullard device. The fluid turbulent process is based on a von-Kármán gallium flow; hence the designation "Bullard-von-Kármán dynamo".

The Bullard-von-Kármán dynamo allows to investigate the influence of the statistical properties of the turbulent induction process on the dynamics of the dynamo. Modifications in the flow forcing are introduced in order to change the dynamics of the flow, and hence of the turbulent induction.

On-off intermittency at onset of dynamo action has been characterized. The on-off intermittent feature appears to be very robust at onset but its range of existence strongly depends on the low frequency spectrum of the turbulent induction process. For some conditions, magnetic field reversals have been observed. The waiting-time distribution between reversals has been found to evolve from power-law to Poisson-like depending on the distance from onset. The large scales fluctuations also have a significant impact on these reversals.

Most of these experimental results can be understood as emerging form a supercritical system subject to multiplicative noise. Some other features (such as reversals) requires the presence of additive noise and their precise understanding remains a challenge. The links and differences with the dynamics of the von-Kármán Sodium dynamo will also be discussed.