# Hydrodynamic bistability in the VKS experiment : evidence of two dynamo branches

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Self-sustained magnetic field has been observed in the Von Kármán Sodium experiment, where a highly turbulent liquid flow is created by the counter rotation of soft iron impellers ([1]). The high level of turbulence, the presence of a shear layer and of helicity make Von Kármán flows good candidates for fluid dynamo generation. These flows have been extensively studied in water experiments, where hydrodynamic bifurcations for asymmetric driving were observed with possible multistability between these different flows ([2]).
The link between some bifurcations observed on the dynamo magnetic field and hydrodynamics bifurcations is still open ; although clues linking them has been reported ([3]).
Recently, a modification of the setup where one of the impeller has been replaced by a stainless steel propeller (aiming at reversing the poloidal flow and creating a *s1t2* flow according to the Dudley and James classification).
We denote $F_1$ the rotation rate of the impeller and $F_2$ the propeller's one. A hydrodynamic bifurcation has been observed when the driving is strongly asymmetric, keeping $F_1$ constant and increasing $F_2$. When the parameter $\theta = F_2 - F_1/F_1 + F_2$ (indicating the asymmetry of the driving) increases, the flow suddenly bifurcates for $\theta = 0.54$ into a state close to a *s1t1* flow with only one poloidal cell and one toroidal cell. Then, when $\theta$ decreases again, we observe an hysteretic behavior of the flow. It recovers its initial state only at $\theta = 0.43$.
The striking fact is that this hydrodynamic bistability is associated to a bistability of the magnetic field. The dynamo magnetic field displays a high amplitude axial dipole on one branch whereas when the flow has bifurcated, the magnetic field is a stationary low amplitude dynamo.
We will study in details the hydrodynamic bifurcation and the associated change on the magnetic field by local and global measurements and show that for two different flows with different level of fluctuations, it exists two stationary dynamo branches with different thresholds.

## Références

1. R. Monchaux et al., Generation of a Magnetic Field by Dynamo Action in a Turbulent Flow of Liquid Sodium *Phys. Review Letters*, **98**, (2007).
2. F. Ravelet et al., Multistability and memory effect in a highly turbulent flow : Experimental evidence for a global bifurcation *Phys. Review Letters*, **93**, (2004).
3. M. Berhanu et al., Bistability between a stationary and a oscillatory dynamo in a turbulent flow of liquid sodium *J. of Fluid Mech.*, **641**, (2009).