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New results the VKS experimental turbulent dynamo.

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The coupling between hydrodynamics and magnetism by induction effects , $i.e.$ magnetohydrodynamics (MHD), is a subject of broad interest. The magnetic field of the earth and of most astrophysical objects result from turbulent flows of electrically conducting fluids : the kinetic energy of the flow is converted into magnetic energy by dynamo effect. This is an instability mechanism, which occurs when a threshold value of the control parameter, the magnetic Reynolds number, is reached. In September 2006 we observed this effect for the first time in a closed homogeneous turbulent flow of liquid sodium at very high Reynolds number in the Von-Karman Sodium (VKS) . Contrary to existing laboratory dynamos, the flow was largely unconstrained, the fluid and the electrical current being free to evolve in the experimental volume. Despite the strong level of the fluctuations of the flow, we observed the growth and saturation of a stationary global mode of the magnetic field at the experiment's characteristic length.Thus, the understanding of the role of turbulence on the instability and on the magnetic field is of high interest. Does turbulence act as noise or does it participate in the magnetic generation process ? If we modify the global properties of the flow, we observe transitions between different magnetic field modes, going from stationary to oscillatory, and, near the frontiers between these modes, interesting dynamical behaviours occur, such as bursts and relaxations cycles. In particular we found a state

with reversals of the magnetic field similar to those of the Earth recorded on the geological time scale. These evolutions present some features of low dimensional chaos, compatible with the interaction between few modes. Finally we observe for the first time bistability from a stationary dynamo to an oscillatory one in a case where we do not expect a qualitative change of the flow. These experimental results could be usefully to understand the temporal evolution of magnetic fields of the Earth, planets and stars.