Liquid metal experiments on dynamo action and magnetically triggered flow instabilities

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The magnetic fields of planets, stars and galaxies are generated by self-excitation in moving electrically conducting fluids. However, magnetic fields also play an active role in cosmic structure formation by destabilizing rotational flows that would be otherwise hydrodynamically stable. For a long time, both effects, i.e. hydromagnetic dynamo action and magnetically triggered flow instabilities, have been the subject of purely theoretical investigations. This situation changed in 1999 when the threshold of magnetic-field self-excitation was exceeded in the two liquid sodium experiments in Riga and Karlsruhe. Since 2006, the VKS dynamo experiment in Cadarache has successfully reproduced many features of geophysical interest such as reversals and excursions. In the same year, the helical version of the magnetorotational instability (MRI) was observed in the PROMISE experiment in Dresden-Rossendorf. More recently, the azimuthal MRI was found at the same facility. First evidence of the current-driven Tayler instability in a liquid metal was obtained, too. The lecture gives an overview about liquid metal experiments on dynamo action and magnetically triggered instabilities. New results from the enhanced PROMISE facility with a strongly symmetrized azimuthal magnetic fields are presented. An outlook on future experiments, including a precession driven dynamo and a large-scale Tayler-Couette experiment to be set-up in the framework of the DRESDYN project, is also given.
