Angular momentum transport by astrophysical turbulence

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Abstract

The turbulent transport of angular momentum is a central quantity in astrophysics, as it is an essential ingredient in the dynamics of many objects, among which the best known are accretion discs or radiative stars. In both cases, the mechanism that generates the turbulence and the amount of angular momentum transported remain to be clearly identified.

Because generating a Keplerian rotation rate is impossible in Taylor-Couette flows, laboratory experiments mostly focused on less turbulent quasi-Keplerian flows, which somehow eludes the question of transport by turbulent fluctuations. In this talk, I will describe a new experiment which provides a laboratory model of accretion disks, reproducing many features of these astrophysical systems: a magnetized and turbulent flow, confined in a thin disk and exhibiting Keplerian rotation. It is then possible to observe, for the first time, the regime predicted by Kraichnan 60 years ago, in which the angular momentum of the fluid is transported only by the turbulent fluctuations. As this so-called ultimate regime is expected in most astrophysical objects, it can be used to predict accretion rates of accretion disks. Using global numerical simulations, I will show that a similar angular momentum transport can also be observed in radiative stellar layers. In this case, the magnetic field plays an active role by triggering a subcritical transition to turbulence.

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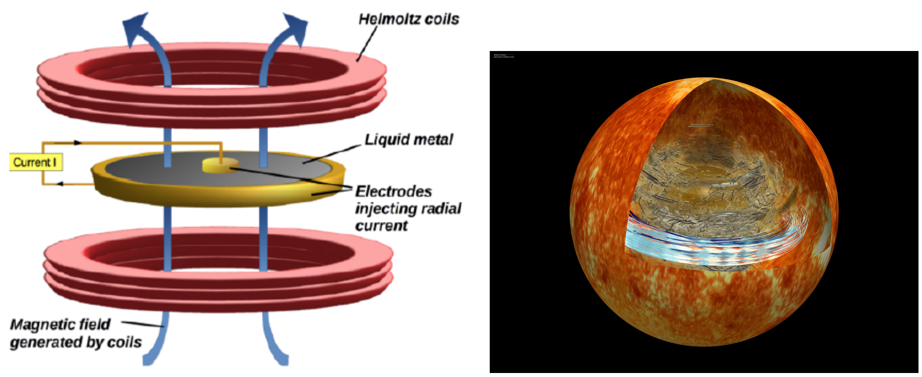

Figure 1: Left: schematic view of the laboratory experiment. Right: Turbulence and magnetic field generated in a radiative star (simulations).

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