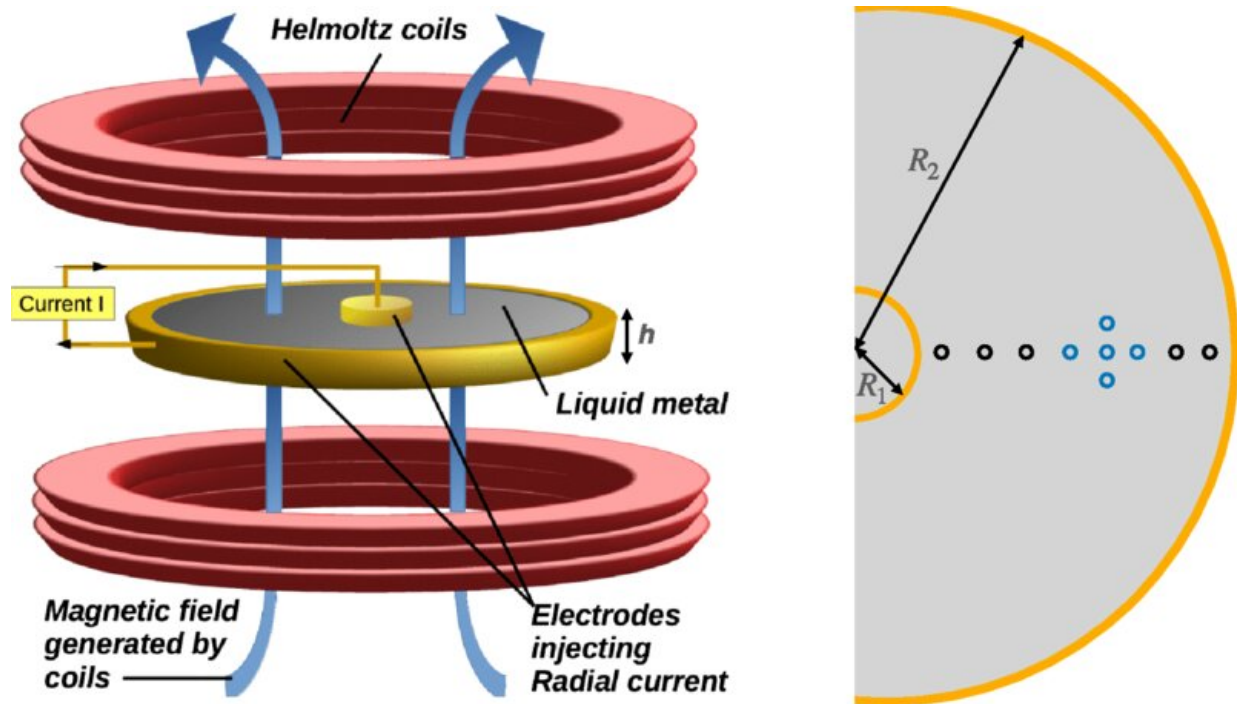


# Using magnetic and electric fields to emulate black hole and stellar accretion disks

August 31 2022, by Bob Yirka



Left: the experimental setup is an annular cylindrical channel with inner radius  $R_1=6\text{cm}$ , outer radius  $R_2=19\text{cm}$  and height  $h=1.5\text{cm}$ , subjected to a radial current ( $I_0=[0-3000]\text{A}$ ) and a vertical magnetic field ( $B_0=[0-110]\text{mT}$ ). Right: a series of potential probes extending from the top plate to midheight provide measurements of both azimuthal and radial velocity field in the midplane. The blue probes measure product  $u_r\Omega$  and derivative  $\partial_r\Omega$  involved in  $J\Omega$ . Credit: *Physical Review Letters* (2022). DOI: 10.1103/PhysRevLett.129.074501

A team of researchers at the Sorbonne University of Paris reports a new way to emulate black hole and stellar accretion disks. In their paper published in the journal *Physical Review Letters*, the group describes using magnetic and electric fields to create a rotating disk made of liquid metal to emulate the behavior of material surrounding black holes and stars, which leads to the development of accretion disks.

Prior research has shown that massive objects have a gravitational reach that pulls in gas, dust and other material. And since such massive objects tend to spin, the material they pull in tends to swirl around the object as it moves closer. When that happens, gravity exerted by materials in the swirling mass tends to coalesce, resulting in an [accretion disk](#).

Astrophysicists have been studying the dynamics of accretion disks for many years but have not been able to figure out how angular momentum is transferred from the inner parts of a given accretion disk to its outer parts as material in the disk moves ever closer to the central object.

Methods used to study accretion disks have involved the development of math formulas, [computer simulations](#) and real-world models using liquids that swirl like eddies. None of the approaches has proven suitable, however, which has led researchers to look for new models. In this new effort, the researchers developed a method to generate an accretion disk made of [liquid metal](#) bits spinning in the air.

To mimic the action of a real-world accretion disk, the researchers applied a radial electrical field to a mass of liquid metal. The field was generated by pushing current between a cylinder and a surrounding circular electrode. The process holds the metal bits captive as they orbit a central point. There is no central body, of course, to mimic a star or black hole—instead, the action is controlled using coils above and below the predefined plane.

Using their approach, the researchers were able to control both the

degree of turbulence and the rotation speed of the disk. They also added probes to learn more about the [angular momentum](#) and found that it was driven from the inner parts of the disk to the outer edges by turbulent flows, as some have theorized.

**More information:** M. Vernet et al, Angular Momentum Transport by Keplerian Turbulence in Liquid Metals, *Physical Review Letters* (2022).  
[DOI: 10.1103/PhysRevLett.129.074501](https://doi.org/10.1103/PhysRevLett.129.074501)

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