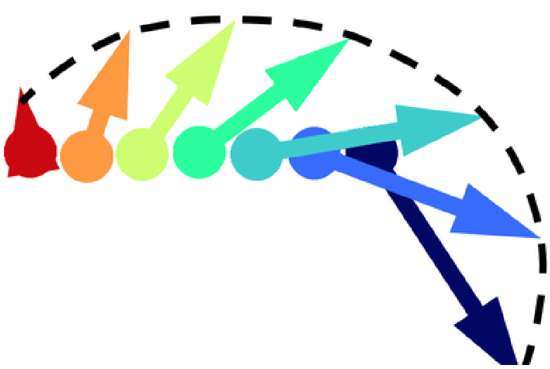
Detection of the Orbital Hall Effect

Two different experiments on two different transition metals reveal that a current of electron orbital angular momentum flows in response to an electric field.

By **Charles Day**

In the spin Hall effect, an applied electric field drives a current of electron spin in a direction transverse to the field. In a transition metal, theorists predict that an orbital angular momentum (OAM) current can also flow. Now two groups have independently observed this so-called orbital Hall effect (OHE) [**1**, **2**]. These observations supplement one made by a third group earlier this year [**3**]. Together these demonstrations constitute a step toward the development of "orbitronic" devices based on an electron's orbital degree of freedom.

For their demonstration, Giacomo Sala of the Swiss Federal Institute of Technology (ETH) in Zurich and his colleagues turned to a phenomenon known as Hanle magnetoresistance. In a conductor, when a magnetic field is applied parallel to the direction of electron OAM, orbital moments should accumulate at the edges of the sample because of the OHE. If instead the field is applied perpendicular to electron OAM, the orbital moments should precess. The orbital moments should then fall out of phase with each other, which boosts the material's magnetoresistance. The team observed these effects in thin films of manganese [**1**].



Credit: G. Sala *et al*. [**1**]

Igor Lyalin of Ohio State University and his colleagues took a different route, instead using the magneto-optical Kerr effect. When linearly polarized light is reflected off a magnetic surface, its plane of polarization is rotated depending on the direction of the local magnetization. A strong OHE should cause electrons of opposite OAM to accumulate at either edge of the sample, which is what the team observed in thin films of chromium [**2**].

Now that the OHE for electrons has been observed, researchers say that they are looking for the predicted counterparts for phonons and magnons.

Charles Day is a Senior Editor for ***Physics Magazine***.

REFERENCES

1. G. Sala *et al.*, "Orbital Hanle magnetoresistance in a 3*d* transition metal," **Phys. Rev. Lett. 131, 156703 (2023).**
2. I. Lyalin *et al.*, "Magneto-optical detection of the orbital Hall effect in chromium," **Phys. Rev. Lett. 131, 156702 (2023).**
3. Y. -G. Choi *et al.*, "Observation of the orbital Hall effect in a light metal Ti," **Nature 619, 52 (2023).**