Generating spin currents directly using ultrashort laser pulses

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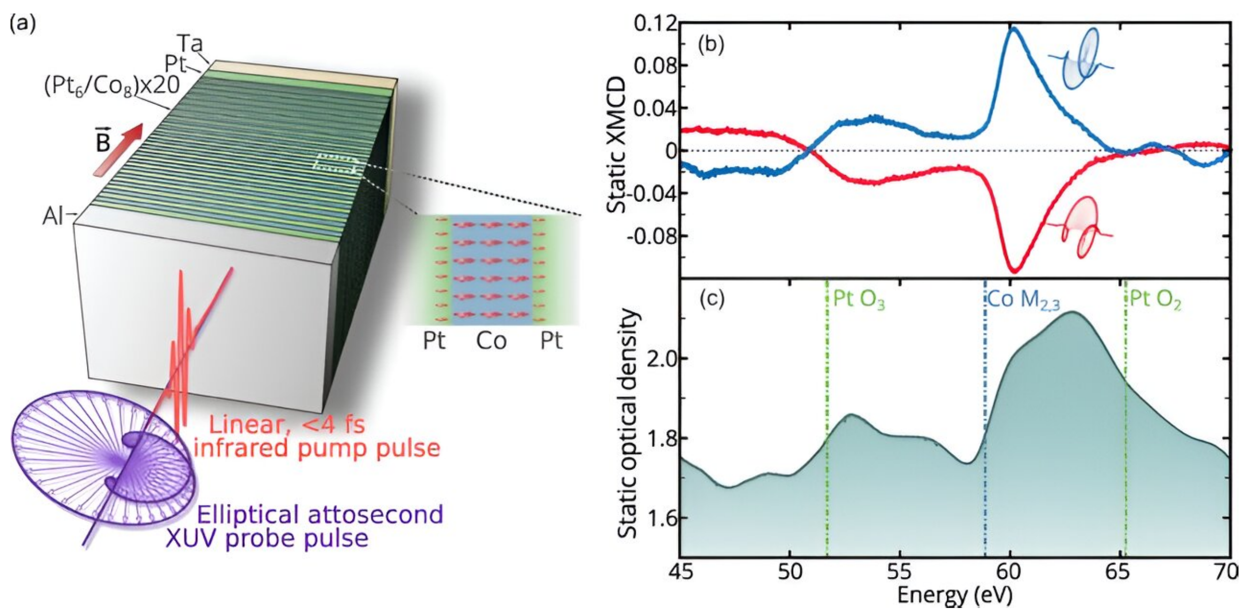

Schematic of the experiment and static characterization. Credit: *Physical Review Letters* (2024). DOI: 10.1103/PhysRevLett.133.106902

An international team of physicists has found that it is possible to generate spin currents directly using certain kinds of ultrashort laser pulses. In their study, published in the journal *Physical Review Letters*, the group used a linearly polarized laser pulse and a circularly polarized probe laser to create the spin currents.

Spin currents are a type of electrical flow where the electrons are organized by aligned spins. Theory has suggested they could lead to electronic devices that run faster—they are also expected to be more efficient, reducing energy costs.

Prior efforts to generate such currents in a usable way have typically involved using lasers to generate the spin, albeit indirectly. These efforts have proved inefficient, however, due to the applied laser generating electrons with mixed orientation, resulting in the need to filter for one or the other. In this new effort, the research team found a way to generate spin currents directly with electrons in the same orientation.

The researchers created a target block made up of 20 alternating layers of platinum and cobalt, each just a single nanometer thick. They next put the block in a vessel and directed a magnetic field at it from the bottom to the top, which made the field perpendicular to the layers in the block—the magnetic field was also strong enough to align the spins of electrons in both of the layered materials.

Next, the researchers fired a polarized laser at the block using short pulses. Then they fired another laser at the block at the same place—this one a circularly polarized probe type. This resulted in shifting the electron spins between the layers making up the block within a few femtoseconds, which the research team notes is faster than the other techniques.

In testing their device, the research team found that the lasers forced a sudden change in magnetic ordering inside of both layers in the block, altering the degree of magnetism. They also used theoretical calculations to approximate the electron interactions and found they agreed with the experimental results.

More information: Romain Géneaux et al, Spin Dynamics across Metallic Layers on the Few-Femtosecond Timescale, *Physical Review*

Letters (2024). DOI: 10.1103/PhysRevLett.133.106902