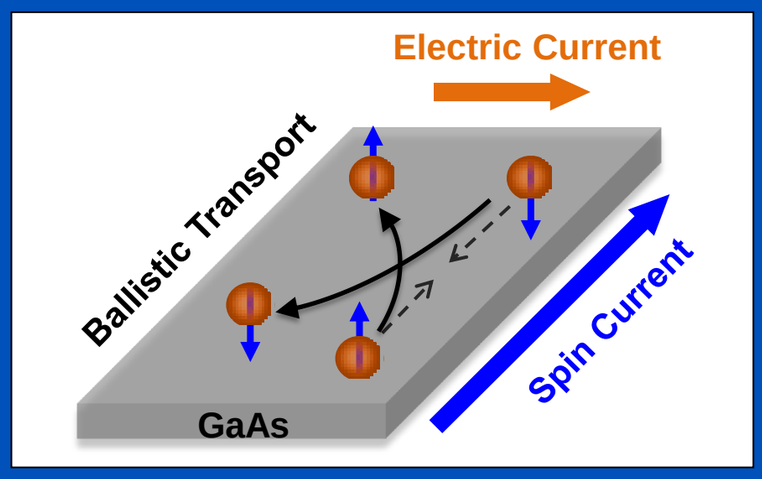
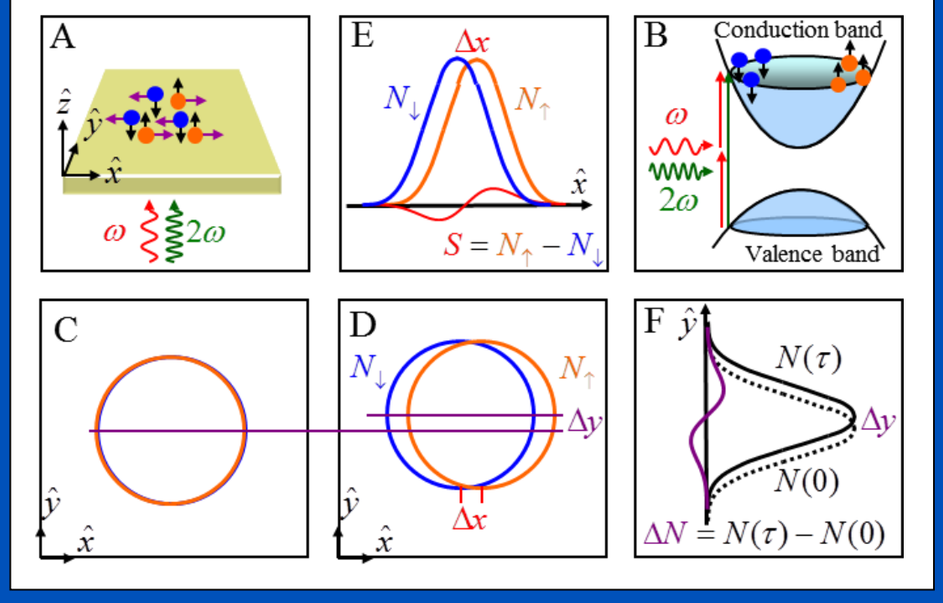
Intrinsic Inverse Spin Hall Effect

A necessary trick for pitching in major league baseball is to throw curved balls by putting a spin on it. We show that the same trick can be played on electrons in semiconductors. The spinning electrons also curve when they fly in semiconductors. This effect is caused by the interaction between the spin motion and the orbital motion of electrons. It can be used to generate and detect spin currents in nanoscale spintronic devices.



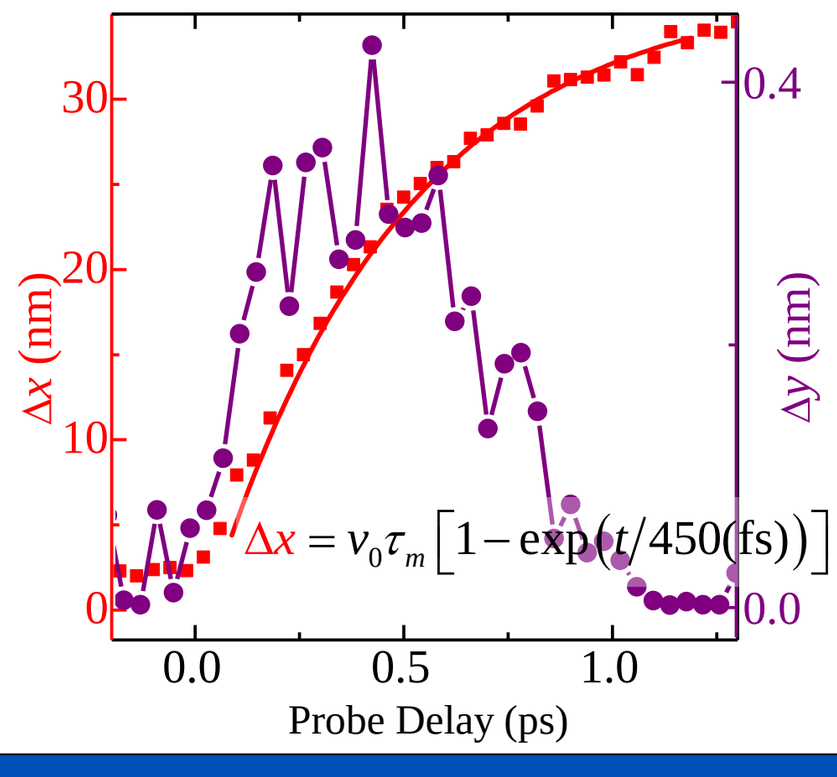


Experimental Approach

- **A and B**: Two femtosecond laser pulses inject a spin current, by sending electrons with opposite spins to opposite directions.
- **C**: Initially, the two spin systems overlap in space.
- **D**: Later, the two separate along x owing to their velocities. The intrinsic inverse spin Hall effect causes both to move along y.
- **E and F**: The nanometer scale movements along x and y are measured by a differential pump-probe technique.

Main Results

- Ballistic transport of electrons directly measured by using a differential pump-probe technique with a temporal resolution of 100 fs and a spatial resolution of 0.1 nm.
- The two spin systems separate along x for about 30 nm in about 1 ps. A fit gives a scattering time (mean free time) of 450 fs.
- The electron movement along y starts before the mean free time: evidence of the intrinsic inverse spin Hall effect.
- After reaching a maximum movement of about 0.3 nm along y, electrons pulled back to origin by the positively charged holes.



Related Publications

PRL **106,** 107205 (2011) PHYSICAL REVIEW LETTERS week ending 11 MARCH 2011

Observation of Intrinsic Inverse Spin Hall Effect

Lalani K. Werake, Brian A. Ruzicka, and Hui Zhao*

Department of Physics and Astronomy, The University of Kansas, Lawrence, Kansas 66045, USA

(Received 18 September 2010; published 9 March 2011)

MRS MATERIALS RESEARCH SOCIETY
Advancing materials. Improving the quality of life.

Home ›

Electrons curve without help - Intrinsic inverse spin Hall effect

Focus: Electrons Curve without Help

Published February 25, 2011 | Phys. Rev. Focus **27**, 8 (2011) | DOI: 10.1103/PhysRevFocus.27.8

Experiments show that the spin of an electron can cause its path to curve as it moves through a semiconductor, even in the absence of scattering, which may be important for future devices.

Ultrafast Laser Lab

Research Highlight

THE UNIVERSITY OF KANSAS