Scientists put the squeeze on electron spins

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University of California scientists working at Los Alamos National Laboratory have developed a novel method for controlling and measuring electron spins in semiconductor crystals of GaAs (gallium arsenide). The work suggests an alternative--and perhaps even superior--method of spin manipulation for future generations of "semiconductor spintronic" devices.

In research published in today's issue of the scientific journal *Physical Review Letters*, Scott Crooker and Darryl Smith describe their use of a scanning optical microscope to acquire two-dimensional images of spin-polarized electrons flowing in semiconductor crystals mounted on an optical cryostat while using a miniature "cryogenic vise" to apply gentle pressure. By squeezing the crystal in a controlled manner, and without applying magnetic fields, the researchers were able to watch the electron spins rotate (or precess) as they flow through the crystal.

According to Crooker, "electrons, in addition to their negative electronic charge, also possess a magnetic "spin". That is, each electron behaves like a little bar magnet, with north and south poles. Electron spins in semiconductors are typically manipulated by applying a magnetic field, but we've found we can do the same thing, in a controlled fashion, using the "vise". And, the resulting degree of spatial spin coherence is remarkably more robust compared to the spin precession induced by a magnetic field."

The cryogenic vise operates at only a few degrees above absolute zero (4 degrees Kelvin) and can be used to intentionally tip, rotate, and flip the electron spins. The research was conducted at the Pulsed Field Facility of the National High Magnetic Field Laboratory (NHMFL) at Los Alamos.

The research was funded by Los Alamos Laboratory-Directed Research and Development (LDRD) funding and the Defense Advanced Research Project Agency's SPins IN Semiconductors (SPINS) Program, which is designed to encourage research to exploit the spin degree of freedom of the electron and create revolutionary electronic devices with the potential to be very fast at very low power.

Alex H. Lacerda, Director of NHMFL-Los Alamos, states, "This work is an excellent example of how the LDRD program engenders strong inter-divisional relationships and enduring experimental-theoretical collaborations at Los Alamos for the pursuit of basic science."

The research fits into a broader area of expertise that Los Alamos National Laboratory maintains in the field of atomic physics in general, and spintronics research in particular.

Source: Los Alamos National Laboratory