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Observing coherent spin motion with electrical currents

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The spin degree of freedom of electrons and nuclei is important for many materials properties of condensed matter. Spins have also been proposed as information carriers for quantum information and spin-electronic applications. The investigation of spin states for materials research and technological applications therefore requires very sensitive spin measurement (readout) techniques. Our research is aimed at the investigation of such spin readout mechanisms for electron and nuclear spins in semiconductor materials. The focus of this work is on spin-selection rules which allow control of electronic transitions such as charge carrier recombination, transport, trapping or scattering. I will present two spin-dependent mechanisms which allow the extremely sensitive observation of coherent spin nutation of electron spins in crystalline silicon and a conducting pi-conjugated polymer, respectively. It will be shown that using these mechanisms, it is possible to observe spin effects such as spin-Rabi nutation, spin-echo, spin inversion recovery and spin polarization by technologically simple transient current measurements.