Traditional computers and electronic devices work by moving electric charges from one place to another. Quantum spins could play a similar role in the growing field of spintronics. However, researchers have not yet fully explored some of their basic properties. Here, a research team led jointly by Christian Gradl from Regensburg University (Germany) and Roland Winkler (NIU) was able to fully characterize, for the first time, a fundamental quantity of electron spins known as the g tensor, which impacts various spin behaviors in the presence of an external magnetic field.

Specifically, the g tensor determines Zeeman splitting (the separation of energy levels) and precession of electron spins in a magnetic field. Using optical spectroscopy, they measured spin precession of valence electrons known as holes in a series of semiconductor quantum wells exposed to strong magnetic fields.

Depending on the orientation of the applied field, they observe highly unusual spin precession; for example, for a magnetic field applied in the plane of the quantum well the spins can precess about an axis that points mostly out-of-plane. Comprehensive theoretical calculations can explain how this counterintuitive behavior comes about, in good agreement with the experimental data.

The study paves the way for making use of Zeeman coupling in quantum information processing schemes. It has been reported in Physical Review X, a highly selective journal published by the American Physical Society intending to break new ground in physics.

https://journals.aps.org/prx/abstract/10.1103/PhysRevX.8.021068