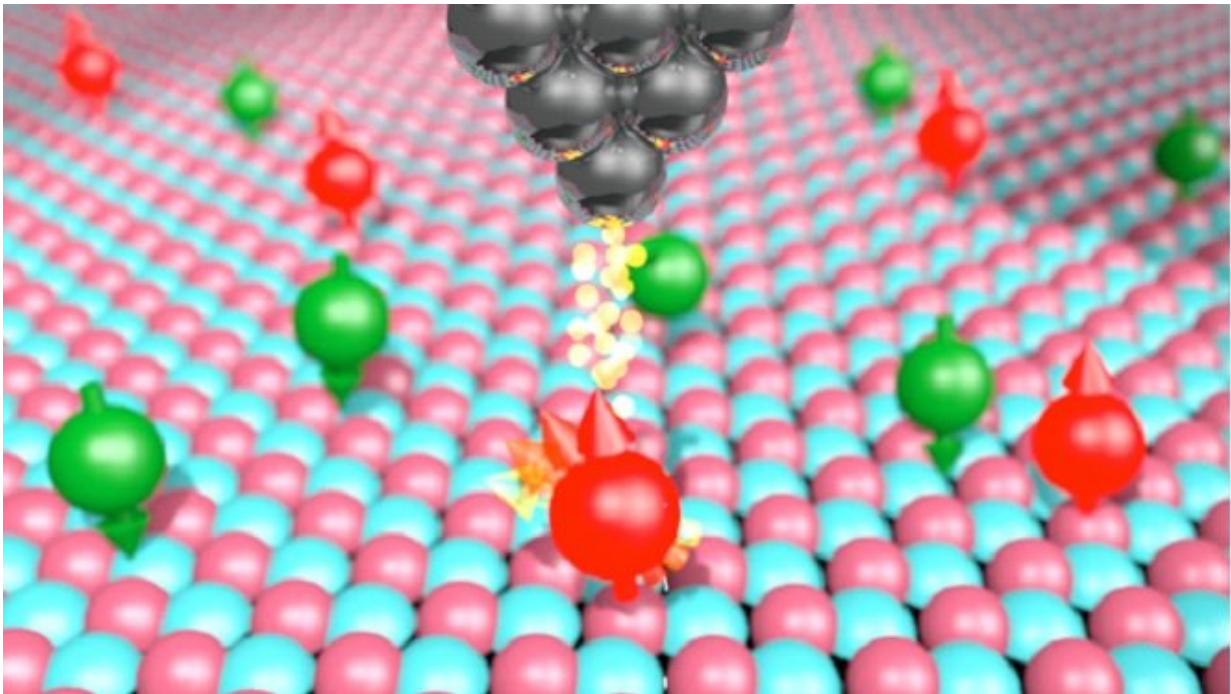


Major discovery in controlling quantum states of single atoms

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The metallic tip of a scanning tunneling microscope is used to drive the magnetic quantum state of an iron atom into a different direction. Credit: Institute for Basic Science (IBS)

Researchers at the Center for Quantum Nanoscience within the Institute for Basic Science (IBS) have made a major breakthrough in controlling the quantum properties of single atoms. In an international collaboration with IBM Research in San Jose, California, using advanced techniques,

the scientists identified which mechanisms destroy the quantum properties of individual atoms by manipulating the magnetic state of a single iron atom on a thin insulator. Using a scanning tunneling microscope with an atomically sharp metal tip, they were able to image individual iron atoms and measure and control the time that they maintain their quantum behavior.

Their findings, published in the journal *Science Advances*, show that the loss in quantum state superposition is mainly caused by nearby electrons that the researchers precisely injected into the iron atom.

"We found that almost every electron destroys the [quantum state](#)," explains Dr. Philip Willke, first author of the study. "In addition, we found that nearby fluctuating magnets had a similar negative impact. While our experiments decreased the state of superposition on purpose, it also gave us valuable clues on how to improve the atoms' quantum states."

Andreas Heinrich, Director of the IBS Center for Quantum Nanoscience, said, "Understanding these destructive interactions allows us to avoid them in future experiments and improve the performance of magnetic quantum sensors that, in this case, only consist of a single atom."

Quantum nanoscience relies on harnessing the properties of atoms and molecules for potential advances in quantum sensing, potentially improving devices using such technology, including hospital MRI machines.

Quantum computers could also potentially benefit from this research. While still in early development, quantum computation promises to outperform classical computers in tasks such as database management, search and optimization. A quantum system can maintain two quantum

states simultaneously, a condition known as the superposition of quantum states. However, when such a [quantum](#) system interacts in particular environments—either through desired or undesired contact—this superposition of [states](#) is easily destroyed. Physicists seek to understand and control these processes.

More information: "Probing quantum coherence in single-atom electron spin resonance" *Science Advances* (2018). [DOI: 10.1126/sciadv.aag1543](#) , advances.sciencemag.org/content/4/2/eaag1543

Provided by Institute for Basic Science

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