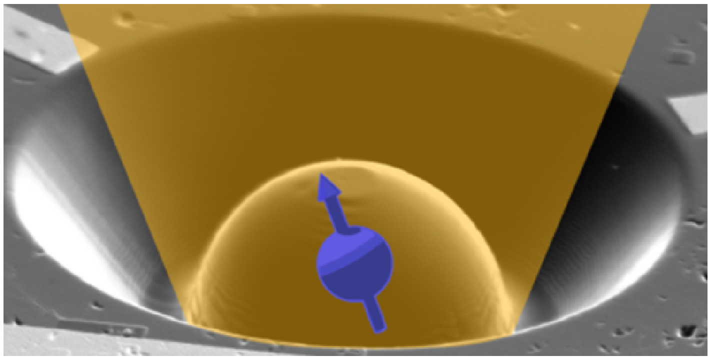
Vetting Neutral Nitrogen Vacancies

New experiments characterize the excitation levels of electrically neutral nitrogen-vacancy centers, information needed for quantum information applications.

By **Michael Schirber**

Nitrogen-vacancy centers are small defects in diamond crystals, which can perform many functions in quantum information and sensing technologies (see **Q&A: Defects Wanted; Apply Here**). Negatively charged (NV^-) centers—those with one extra electron—have proven to be the most useful, but the defects also come in a less-studied neutral state (NV^0). Now, Simon Baier from Delft University of Technology in the Netherlands and his colleagues have performed a series of optical spectroscopy experiments that reveal the excitation levels in NV^0centers, knowledge that could improve the applicability of nitrogen-vacancy centers [**1**].

Like an atom, nitrogen-vacancy centers have several bound electrons, which can reside in one of many orbitals. The NV^-center—with six electrons—is prized for its long-lived spin states that can store quantum information. However, under laser excitation an NV^-center can spontaneously lose an electron and switch to NV^0, resulting in a loss of signal and the decoherence of nearby qubits. Those problems could be mitigated if the NV^0center's spin properties were better understood.



Credit: QuTech/Delft University of Technology

NV^0 centers rapidly undergo transitions, making it difficult to identify the initial and final states of a given transition. Baier and colleagues overcome this problem by developing a technique that can carefully place a single nitrogen-vacancy center in a well-defined state. By monitoring the light emission from this targeted center, they showed that they could clearly identify transitions involving orbital-state changes from those involving spin-state changes. They also measured how the spin states evolve, both in the dark and under laser illumination. They then used this information to demonstrate a low-error (high-fidelity) readout technique of the NV^0 spin state that could be used in future qubit applications.

Michael Schirber is a Corresponding Editor for ***Physics*** based in Lyon, France.

REFERENCES

1. S. Baier *et al.*, "Orbital and spin dynamics of single neutrally-charged nitrogen-vacancy centers in diamond," **Phys. Rev. Lett. 125, 193601 (2020).**