Longer Lived Molecules

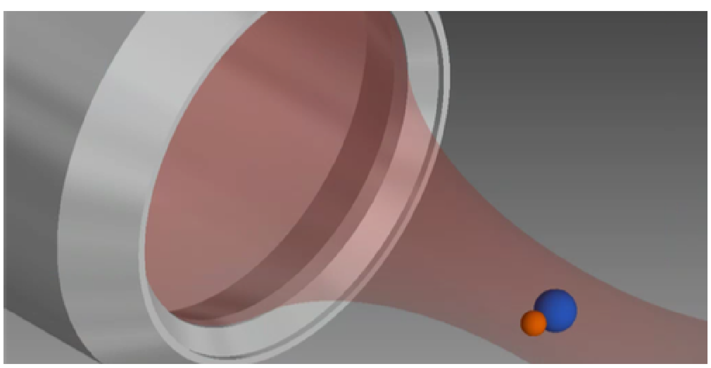
Researchers merge two atoms into a molecule that has a precise, reversible quantum state and that lives long enough to measure.

By **Katherine Wright**

Individual molecules placed in precisely defined quantum states could provide the building blocks for molecular arrays for quantum computing applications. But first, researchers need to develop techniques for creating these molecules. Now Jessie Zhang at Harvard University and colleagues demonstrate such a technique for forming a long-lived single NaCs molecule in a specific, reversible quantum state.

In the experiment, the team confined one Na atom and one Cs atom together at the center of a laser tweezer trap. They then applied a magnetic field to the trap, causing the atoms to bind in a process known as magnetoassociation. When the Na and Cs atoms were in their lowest motional states, then so was the molecule. But when the individual atoms were in excited states, the molecule formed a rotationally excited state. Inverting the procedure, the team found that the process was fully reversible: they recovered the original atoms in their original states.

The new technique improves on two earlier methods demonstrated by the same group. Both of these approaches created molecules in precisely characterized quantum states, using lasers to associate the atoms. In one case, the excited molecules quickly decayed into other states, which were undetectable (see **Meetings: Building a Molecule Atom by Atom**). In the other case, the lasers that were used to make the molecules then destroyed them before the team could make measurements (see **Focus: A Quantum Molecular Assembler**). The latest method overcomes both of these problems, producing molecules that lived for 4.7 ms. Zhang says that further work is needed to create usable molecules for quantum science applications, but this longer lifetime makes that work possible.



Credit: J. Zhang/Harvard University

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Katherine Wright is a Senior Editor for ***Physics***.