Gaining a better understanding of what happens when two atoms meet

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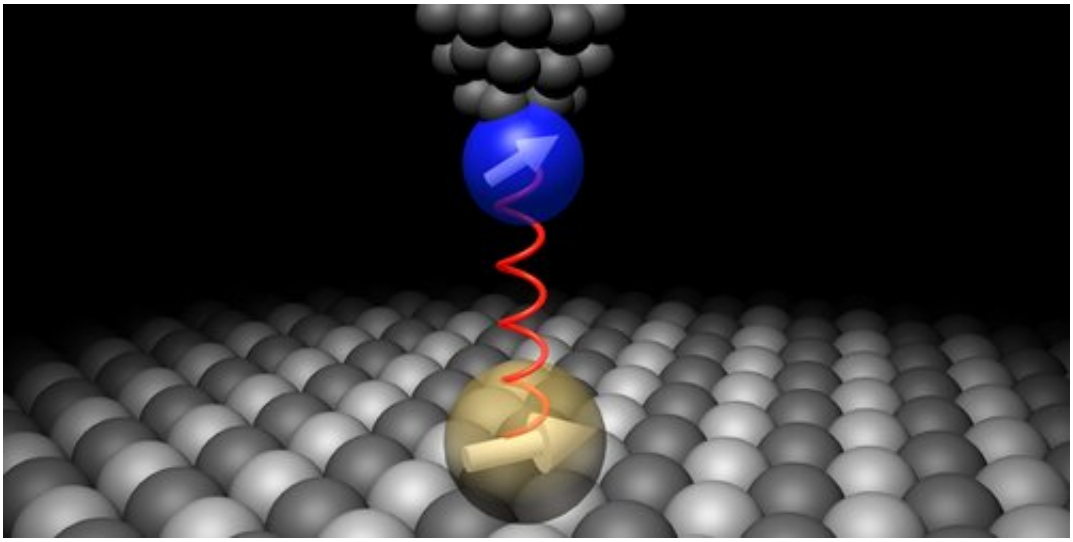

Credit: K. Yang et al., Phys. Rev. Lett. (2019)

An international team of researchers has demonstrated a new way to gain a detailed understanding of what happens when two atoms meet. In their paper published in the journal *Physical Review Letters*, the group describes their experiments, which involved observing closely as two atoms came into contact with one another.

The idea of watching two atoms collide might make some people uneasy, as they envision a nuclear bomb going off, but not all such collisions are so dramatic. In this new effort, the researchers measured the magnetic interaction that occurred as two atoms were brought very slowly into

contact with one another.

Prior research has shown that atoms have what are known as wave functions, which are defined by the probability-based orbits of their electrons. Prior research has also shown that when two atoms move into proximity, as their waveforms overlap, a force called "exchange interaction" arises—and it grows as the two move closer together. The exchange interaction happens all the time, as when you press two fingers together, or in chemistry experiments. But until now, no one had accurately measured its force progressively as two atoms came into proximity. In this new experiment, the researchers have made such a measurement in their lab.

The team placed a single titanium atom atop a layer of magnesium oxide, which served as an insulator. They next placed a single iron atom on the tip of a scanning tunneling microscope's probe. Then, they slowly moved the single iron atom toward the single titanium atom. As they did so, they measured the magnetic effect on the two atoms via two methods. The first was electron spin resonance—a technique that provided very detailed measurements of the weaker interactions. The second involved the use of inelastic electron tunneling spectroscopy—it gave better results when measuring the stronger interactions. Using two methods of measurement gave the researchers more confidence in their results when they matched. The procedure allowed the researchers to achieve a new level of precision in measuring exchange interactions. It also demonstrated a possible technique for tuning an atom's magnetic field in a way that might be practical in data storage devices of the future.

More information: Kai Yang et al. Tuning the Exchange Bias on a Single Atom from 1 mT to 10 T, *Physical Review Letters* (2019). DOI: 10.1103/PhysRevLett.122.227203 , arxiv.org/abs/1906.03213