Relativistic effects on long-range interactions between objects

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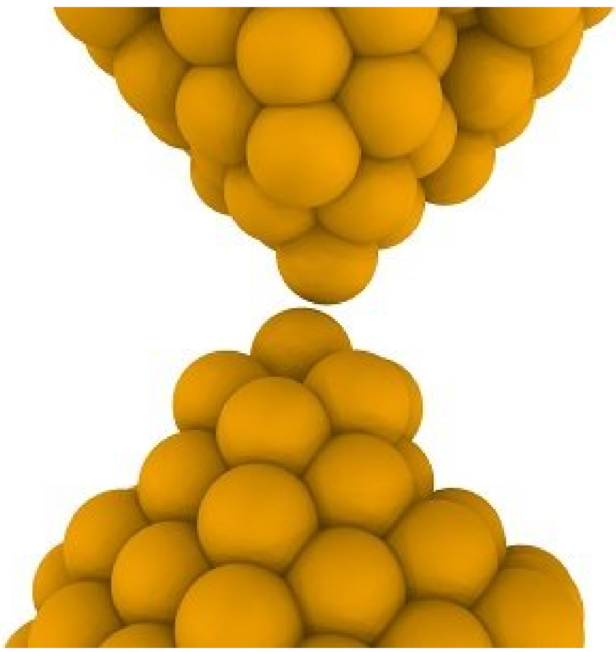

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A team led by researchers María José Caturla and Carlos Untiedt, from the University of Alicante Department of Applied Physics, have studied the importance of relativistic effects on long-range interactions between objects. They have published their results in two articles from the American Physical Society's flagship journal *Physical Review Letters*.

The researchers discovered that Albert Einstein's laws of relativity determine the distance at which forces between two objects start acting.

"It is surprising to see how Einstein's special relativity influences everyday processes, such as the one whereby two objects touch. We proved that due to this effect, heavier elements, for instance gold, exert forces on others at longer distances than one would expect if it were not for special relativity," physicist Carlos Untiedt explains.

These forces are highly important to understand a variety of processes, including chemical reactions or friction. Untiedt says, "These effects will be essential to quantitatively understand how molecular bonds are formed between atoms."

Einstein's theory of special relativity is useful to plan space travel and plays a key role in everyday technology. For instance, it enables GPS systems to accurately calculate positions. Untiedt says, "Einstein's relativity is relevant in cosmic or global phenomena, but it is also fundamental when it comes to understanding certain properties of matter at a microscopic level. As elements in the periodic table become heavier, electrons move around the nucleus faster, and reach speeds at which relativistic effects cannot be dismissed."

Such is the case of gold, which has an electronic structure similar to those of silver and copper, but a considerably greater atomic mass. "Relativistic effects are therefore greater in gold and determine many of its properties, as, when its electronic properties change, relativity affects atomic bonding, among other things," the UA researcher explains.

"In our study, we have proved how relativity affects the way two gold electrodes come into contact with each other. To that end, we have measured the distance at which a single atom of a metallic electrode is attracted by a second electrode approaching it," Untiedt adds.

These experiments allowed researchers to determine that, in the case of gold, electrodes interact at much longer distances than when silver or copper are involved. "With the help of theoretical simulations, it was proved that the attraction between gold atoms at long distances is mostly explained by relativity." In summary, Untiedt says, "We proved the influence of relativistic effects on the mechanical properties of metals at a microscopic level."

More information: M. R. Calvo et al. Influence of Relativistic Effects on the Contact Formation of Transition Metals, *Physical Review Letters* (2018). DOI: 10.1103/PhysRevLett.120.076802

C. Sabater et al. Role of first-neighbor geometry in the electronic and mechanical properties of atomic contacts, *Physical Review B* (2018). DOI: 10.1103/PhysRevB.97.075418

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