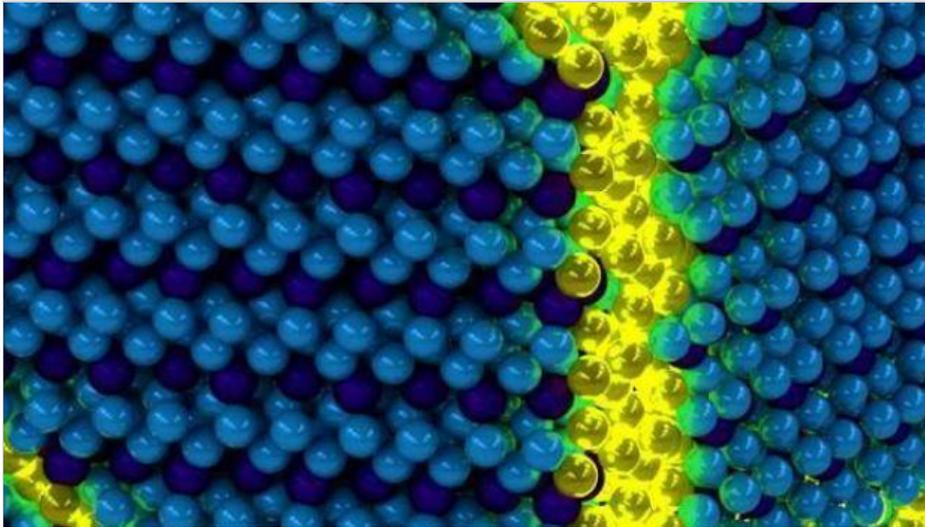


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# SCIENTISTS CONFIRM DISCOVERY OF A NEW FORM OF MATTER

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Credit: Peter Abbamonte

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Nearly 50 years after it was theorized, physicists have finally proven the existence of a new form of matter, called excitonium

Some of the theories in the field of physics are extremely complicated and take decades to prove with experiments. Such is the case with a perplexing form of matter called excitonium. The matter was first theorized almost 50 years ago, but until now, it was not confirmed and lacked definitive proof.

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For the first time, a combined team of researchers have proven the existence of excitonium and their findings will help answer fundamental questions about the nature of the matter.

“This result is of cosmic significance. Ever since the term 'excitonium' was coined in the 1960s by Harvard theoretical physicist Bert Halperin, physicists have sought to demonstrate its existence. Theorists have debated whether it would be an insulator, perfect conductor or a superfluid – with some convincing arguments on all sides. Since the 1970s, many experimentalists have published evidence of the existence of excitonium, but their findings weren't definitive proof and could equally have been explained by a conventional structural phase transition.” Professor Peter Abbamonte from University of Illinois said in a [statement](#).

Excitonium is made up of excitons. A type of particles that are formed in a very strange quantum mechanical pairing – an escaped electron and the hole it left behind.

Previously, researchers confused excitonium with Peierls phase transition. Though both are unrelated, they have same symmetry and similar observables. In the latest effort, researchers examined non-doped crystals of transition metal dichalcogenide titanium diselenide (1T-TiSe2) and replicated the results five times on different cleaved crystals.

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Researchers found that when an electron gets excited and jumps, it leaves behind a hole. Then, the hole that has positive charge attracts the negatively charged escaped electron and pair up with it. The two form a composite particle known as boson, which is an exciton.

The discovery was made possible by a novel technique called momentum-resolved electron energy-loss spectroscopy or M-EELS. M-EELS is more sensitive to excitations than other conventional techniques.

The technique measures an electron's momentum very precisely. With the help of it, researchers were able to make first ever observations of paired electrons and holes. Moreover, they found that the energy of the electronic mode fell to zero at nonzero momentum near the phase-transition temperature (190 kelvin). The phase is "smoking gun" proof of exciton condensation in a three-dimensional solid and the first-ever definitive evidence for the discovery of excitonium.

"The excitement generated by this discovery remained with us throughout the entire project," said researcher Mindy Rak. "The work we did on TiSe2 allowed me to see the unique promise our M-EELS technique holds for advancing our knowledge of the physical properties of materials and has motivated my continued research on TiSe2."

The research also holds great promise for unlocking quantum mechanical mysteries.

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