

New form of matter 'excitonium' discovered

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Scientists have proven the existence of new form of matter called excitonium – which was first theorised almost 50 years ago.

Researchers from University of California and University of Illinois studied non-doped crystals of a transition metal—dichalcogenide titanium diselenide (1T-TiSe2).

Excitonium exhibits macroscopic quantum phenomena, like a superconductor and is made up of excitons, particles that are formed in a very strange quantum mechanical pairing.

When an electron, seated at the edge of the crowded-with-electrons valence band in a semiconductor, gets excited and jumps over the energy gap to the otherwise empty conduction band, it leaves behind a “hole” in the valence band. That hole behaves as though it were a particle with positive charge, and it attracts the escaped electron. When the escaped electron with its negative charge, pairs up with the hole, the two remarkably form a composite particle, a boson – an exciton.

The team used a novel technique called momentum-resolved electron energy-loss spectroscopy (M-EELS) for the study. With their new technique, the group was able to measure collective excitations of the low-energy bosonic particles, the paired electrons and holes.

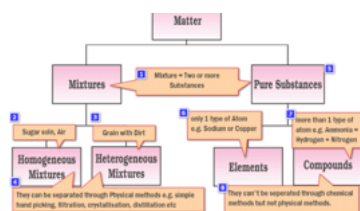
“Ever since the term ‘excitonium’ was coined in the 1960s by Harvard theoretical physicist Bert Halperin, physicists have sought to demonstrate its existence,” said Peter Abbamonte, professor at University of Illinois. “Theorists have debated whether it would be an insulator, a perfect conductor, or a superfluid—with some convincing arguments on all sides,” Dr. Abbamonte said.

The findings, published in the journal Science, holds great promise for unlocking further quantum mechanical mysteries, researchers said.

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