

## Scientists Have Discovered a New Form of Matter Called "Excitonium"

Rodiano Bonacci Dicembre 10, 2017 [Condividere](#)



This is the first proof of the matter since its existence was theorized some fifty years ago.

The research was led by **Peter Abbamonte** from University of Illinois at Urbana-Champaign, working with the graduate students **Anshul Kogar** and **Mindy Rak**, and receiving input from colleagues at Illinois, University of California, Berkeley, and University of Amsterdam. Such is the case with a perplexing form of matter called excitonium. A type of particles that are formed in a very odd quantum mechanical pairing - an escaped electron and the hole it left behind.

The team studied non-doped **crystals** of the oft-analyzed transition metal dichalcogenide titanium diselenide (1T-TiSe<sub>2</sub>) and reproduced their surprising results five times on different cleaved **crystals**. It resists reason, but it turns out that when an electron, seated at the corner of a packed-with-electrons valence band in a semiconductor, gets fired and jumps over the energy gap to the contrarily empty conduction band, it leaves behind a "hole" in the valence band. The hole actually behaves like a positively-charged particle itself.

Until now, scientists had not had the experimental tools needed to distinguish with certainty whether they were detecting excitonium or another similar phase of matter.

Previously, researchers confused excitonium with *Peierls phase* transition. This time, however, researchers used a two measuring devices: an EEL spectrometer and a goniometer, and created a new technique they termed "momentum-resolved electron energy-loss spectroscopy (M-EELS)".

"Ever since the term "excitonium" was invented in the 1960s by Harvard theoretical physicist Bert Halperin, physicists have sought to demonstrate its existence", stated **Peter Abbamonte**, a professor at the University of IL. "Scientists have questioned whether it would be a nonconductor, a complete conductor, or a superfluid with some convincing debates on all sides", Abbamonte stated. M-EELS is more sensitive to valence band excitations than inelastic X-ray or neutron scattering techniques. With the help of it, researchers were able to make first ever observations of paired electrons and holes.

Many scientists have published evidence of excitonium existence, but they do not have

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definitive proof of their findings. "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 discovery of [exciton](#) holds promise for unlocking further quantum mechanical mysteries, since the study of macroscopic quantum phenomena has shaped humanity's understanding of quantum mechanics. In-band solids, it will throw some light on the metal-insulator transition in which it is believed that condensation play a role as well as the applications of the excitonium are purely speculative.

While the discovery gives us a more detailed understanding of another mystery of quantum mechanics, the practical applications of excitonium are now in a speculative stage.

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