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Discovery of "Pseudogap" Behavior in a Monolayer Thick High-Temperature Superconductor

D.G. Schlom and K.M. Shen, Cornell University

The ability to produce pristine atomic interfaces by growing the structures atom-by-atom *via* molecular beam epitaxy has opened the door to an entirely new class of emergent phenomena in the form of interface quantum materials. One remarkable example of such a material system is the interface between monolayer iron selenide (FeSe) films and $SrTiO_3$, where superconductivity can be observed at dramatically higher temperatures compared to 8 K of bulk FeSe. So far, the inherent fragility of such ultra-thin layers has prevented the direct study of superconductivity *via* direct probes like electrical resistivity.

To overcome this challenge, **members of PARADIM's in-house research team employed a combination of angle-resolved photoemission spectroscopy and *in situ* resistivity measurements** to simultaneously probe both the electronic states and superconducting behavior of pristine monolayer $FeSe/SrTiO_3$. Using this unique approach, PARADIM scientists were able to reveal a striking dichotomy between the spectroscopic and transport properties of monolayer $FeSe/SrTiO_3$. While spectroscopy indicates the initial formation of a superconducting gap at temperatures as high as 70 K, a true zero-resistance state was not achieved until below 30 K. Furthermore, they showed that this discrepancy is due to an unprecedentedly large "pseudogap regime"—a suppression in the density of states extending above the superconducting critical temperature—not previously observed in iron-based superconductors, but which arises in this case from the intrinsic 2D nature of the system.

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