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External User Project - 2021

PARADIM – an Incubator for Collaborations II

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Since the discovery of high-temperature superconductivity in copper-based oxides (cuprates), there has been a sustained effort to understand its origin and to discover new superconductors based on similar building principles. Indeed, superconductivity has recently been discovered in the doped rare-earth nickelate $Nd_{0.8}Sr_{0:2}NiO_2$. Undoped $NdNiO_2$ is the infinite-layer end member of a larger family of layered nickelates, which can be explored by molecular beam epitaxy (MBE).

Here, experimentalists and theoreticians **connecting at PARADIM** engineered superconductivity through dimensional confinement in these layered systems without the need for chemical doping. Using **PARADIM's signature MBE**, the team grew various stacked films each incorporating a precisely tuned number of layers as confirmed experimentally in **PARADIM's Electron Microscopy Facility**. They demonstrated superconductivity for the 5-layer system with a critical temperature T_c = 13 K. The theoretical analysis reveals that the electronic structure of the 5-layer system can be understood as qualitatively intermediate between that of the cuprates and the infinite-layer nickelate. Engineering a distinct superconducting nickelate using a closed Materials-by-Design loop paves the way to explore nickelates as a new family of superconductors, which can be tuned by dimensionality and doping.

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