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Understanding anisotropy to develop superconducting design principles

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Superconductivity is often found in families of compounds which share a common building block (e.g. CuO_2 planes in cuprates, FeAs planes in pnictides, and $CeIn_3$ planes in a subset of heavy fermion superconductors). This fact provides a rationale to search for new superconductors, and subsequently a means to try and understand the origin of superconductivity by examining trends in superconducting behavior within a family of superconductors which hopefully transcends any one particular family of compounds. The notion of common building blocks has led us to the recent discovery of superconductivity at 2.1 K in $CePt_2In_7$, coexisting magnetism and superconductivity in $PuCoIn_5$, and a correlated paramagnet in $PuPt_2In_7$. I will discuss our attempts to understand the role of reduced dimensionality and increased bandwidth within the "115" class of heavy fermion superconductors by examining trends in the charge and spin degrees of freedom that are correlated with superconductivity. In this way, we aim to lay the foundation for a modern, microscopic version of Matthias' rules for unconventional superconductivity from which superconducting design principles can be developed. In collaboration with Eric Bauer, Jianxin Zhu, Paul Tobash, Moaz Altarawneh, HB Rhee, Hironori Sakai, Kris Gofryk, Neil Harrison, and Joe Thompson.