

CONDENSED MATTER COLLOQUIUM SERIES

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Transport and Magnetism in Ultraclean Delafossite Metals

In this seminar, I will review my group's recent work on the complex oxide materials known as metallic delafossites. These materials, such as PdCoO_2 and PdCrO_2 , are the most conductive oxides known, despite their complex oxidic nature and highly anisotropic structures. PtCoO_2 , for example, is more conductive than Au at room temperature, while at low temperatures PdCoO_2 has a staggering electronic mean-free-path of 20 nm. I will first describe new bulk growth approaches that have increased the size and quality of the crystals of these materials by substantial factors [1-3]. I will then discuss our progress understanding how nonmagnetic PdCoO_2 reaches the levels of purity and perfection needed to enable such mean-free-paths, particularly via a sublattice purification mechanism [2]. I will then move on to PdCrO_2 , where frustrated antiferromagnetism adds an additional dimension, resulting in phenomena such as an unconventional anomalous Hall effect. This anomalous Hall effect is not only very large but also extends to as high as seven times the Néel temperature, driven by short-range frustrated chiral spin fluctuations [3]. Finally, the dilute alloy $\text{PdCo}_{1-x}\text{Cr}_x\text{O}_2$ is discussed, where unique forms of spin-glass freezing and Kondo effect emerge [4]. Extraordinary optical properties, including hyperbolicity will also be touched upon [5].

[1] "Thermal properties of the metallic delafossite PdCoO_2 : a combined experimental and first-principles study", Y. Zhang, A. Saha, F. Tutt, V. Chaturvedi, B. Voigt, W. Moore, J. Garcia-Barriocanal, T. Birol and C. Leighton, Phys. Rev. Mater. 6, 115004 (2022).

[2] "Crystal-chemical origins of the ultrahigh conductivity of metallic delafossites", Y. Zhang, F. Tutt, G.N. Evans, P. Sharma, G. Haugstad, B. Kaiser, J. Ramberger, S. Bayliff, Y. Tao, M. Manno, J. Garcia-Barriocanal, V. Chaturvedi, R.M. Fernandes, T. Birol, W.E. Seyfried Jr., and C. Leighton, Nat. Commun. 15, 1399 (2024).

[3] "High-temperature anomalous Hall and magnetoresistance effects driven by frustrated spin fluctuations in the antiferromagnetic metallic delafossite PdCrO_2 ", Y. Tao, P. Jain, Y. Zhang, F. Tutt, D. Phelan, C. Balz, S. Hatt, J. Neufeind, S. Rosenkranz, B. Frandsen, and C. Leighton, submitted (2025).

[4] P. Jain et al., in preparation (2025).

[5] "Dual optical hyperbolicity of PdCoO_2 and PdCrO_2 delafossite single crystals", S. Macis, A. D'Arco, E. Del Re, L. Mosesso, M.C. Paolozzi, V. Stagno, A. McLeod, Y. Tao, P. Jain, Y. Zhang, F. Tutt, M. Centini, M.C. Larciprete, C. Leighton and S. Lupi, Adv. Funct. Mater. e12820 (2025).

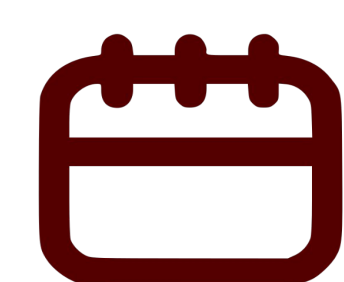
Chris Leighton is a Distinguished McKnight University Professor of Chemical Engineering and Materials Science and a graduate faculty member in Physics at the University of Minnesota (UMN). Following Bachelor's and Ph.D. degrees in Physics at the University of Durham in the UK (1994, 1998), he pursued post-doctoral research at UC San Diego (1998-2001), then joined the UMN faculty in 2001. His research deals with electronic and magnetic properties of novel materials and devices, currently spanning complex oxides, electrolyte gating, metallic spintronics, and earth-abundant photovoltaics. He has authored 260 publications, which have accumulated 18,000 citations. He has received honors that include Fellowship in the American Physical Society, the Institute of Electrical and Electronics Engineers, and the Neutron Scattering Society of America, as well as the Cozzarelli Prize from the Proceedings of the National Academy of Sciences. He currently serves as Director of the NSF MRSEC at UMN and was founding Lead Editor of Physical Review Materials from 2017-2025.

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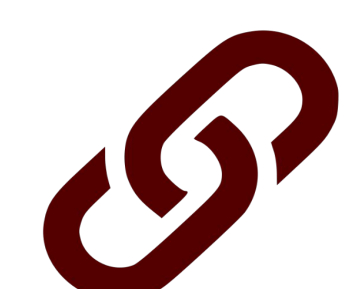


Dec, 09, 2025

Tuesday



19:00, (Ankara Time)



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