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Possible Weyl state near the metal-insulator boundary in pyrochlore iridates

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Despite a rapidly growing theoretical literature on Weyl semi-metallic states, such states are proving elusive in real materials. Promising candidates, initially proposed by Wan et al.[1] and Witczak-Krempa et al. [2], are the pyrochlore iridate systems $R_2Ir_2O_7$, where R is a rare earth. In this talk I will review experimental evidence for unconventional normal states near the metal-insulator boundary in these systems, focusing on $Eu_2Ir_2O_7$, where we have carried out transport measurements under pressure [3]. In measurements up to 12 GPa, we found a peculiar insulator-to-metal transition near 7 GPa. Across this pressure range magnetic order – a prerequisite for a Weyl state in the pyrochlore lattice – seems to be relatively unaffected, with $T_N \simeq 100 - 120$ K at all pressures. The normal state above 7 GPa is unusual, having a negative temperature derivative of resistance. Magnetoresistance measurements at 10 GPa down to 100 mK suggest the existence of small Fermi pockets. These behaviors may be consistent with a Weyl semi-metallic state near the metal-insulator boundary. Further transport measurements that could help to establish this are currently under way, and will be briefly described.

[1] X. Wan, A. M. Turner, A. Vishwanath and S. Y. Savrasov, Phys. Rev. B vol. 83 (2011) 205101.
[2] W. Witczack-Krempa and Y. B. Kim, Phys. Rev. B vol. 85 (2012) 045124.
[3] F. F. Tafti, J. J. Ishikawa, A. McCollam, S. Nakatsuji and S. R. Julian, Phys. Rev. B vol. 85 (2012) 205014.