



BOSE COLLOQUIUM

Monday, 24 November 2014

4:00 p.m.

Fermion

Speaker:

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Title:

New Orders in Simple Solids

Abstract:

Control of the electronic and magnetic properties of materials often involves the formation of additional orders within simple structure types such as perovskite, spinel, rocksalt, etc. These orders may be of atoms, vacancies, charges, and orbital or spin states. High pressure conditions are used both to synthesise such solids and also to drive ordering transitions towards zero temperature where quantum fluctuations dominate [1]. This talk will illustrate the progression from long range motifs to molecule-like objects driven by the d-states within ordered superstructures of transition metal compounds. Long range superstructures will be illustrated by the discovery of large-period vacancy ordered planes in SrCrO_{3-x} materials [2,3] - these are synthesised through 'hard-soft' chemistry starting from the high pressure perovskite SrCrO_3 [4]. More unconventional, polymer-like, correlated orders of O and N atoms have recently been discovered in oxynitride perovskites such as SrTaO_2N [5,6,7]. These have an unusual sub-extensive scaling of entropy with particle size [8]. The low temperature phase of magnetite, Fe_3O_4 , has been an enduring mystery since it was first reported by Verwey in 1939. Our recent determination of the superstructure shows that it is charge and orbitally ordered to a good approximation, but with an additional orbital molecule order of 3-site 'trimeron' units [9, 10].

1. A.F. Kusmartseva, A. Sinclair, J.A. Rodgers, S.A.J. Kimber and J.P. Attfield. *Phys. Rev. B* 87, 165130 (2013).
2. A.M. Arevalo-Lopez, J.A. Rodgers, M.S. Senn, F. Sher, J. Farnham, W. Gibbs and J.P. Attfield. *Angew. Chem.* 51, 10791 (2012).
3. A.M. Arevalo-Lopez, F. Sher, J. Farnham, A.J. Watson and J.P. Attfield. *Chem. Mat.* 25, 2346, (2013).
4. L. Ortega-San-Martin, A. J. Williams, J. A. Rodgers, J. P. Attfield, G. Heymann and H. Huppertz, *Phys. Rev. Lett.* 99, 255701 (2007).
5. Yang, M.; Oró-Solé, J.; Kusmartseva, A.; Jorge, A. B.; Rodgers, J.; A. Fuertes, A. & Attfield, J.P. *Nature Chem.* 3, 47 (2011).
6. Attfield, J.P. *Cryst. Growth. Des.* 13, 4623 (2013).
7. L. Clark, J. Oró-Solé, K.S. Knight, A. Fuertes & J.P. Attfield, *Chem. Mat.* 25, 5004 (2013).
8. Camp, P. J.; Fuertes, A.; Attfield, J. P. *J. Am. Chem. Soc.* 134, 6762 (2012).
9. Senn, M.S.; Wright, J.P. & Attfield, J.P. *Nature* 481, 173 (2012).
10. Senn, M.S., Loa, I., Wright, J.P. & Attfield J.P.. *Phys. Rev. B* 85, 125119 (2012).
