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Magnetic ordering in double perovskites with 4d and 5d elements

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B-site ordered double perovskites of the type AA'BB'O6 have attracted attention recently due to unusual and unpredictable modes of magnetic order. Of particular interest are materials where AA' = Ba, Sr or La and B' = Mo,Ru,Os and Re and B is a diamagnetic ion such as Li+,Na+,Ca2+, Mg2+, Zn2+ or Cd2+.Crystal symmetries encountered are Fm-3m, I4/m and P21/n as a function of the Goldschmidt tolerance factor which in turn impose local symmetries at the magnetic B' site of m-3m, 4/m and -1, respectively. The magnetic ions have electronic configurations 4d1, 4d3,5d1, 5d2 and 5d3 with nominal spins, S = 1/2,1 and 3/2. Spin orbit coupling is very large, reaching ~ 0.5eV for the 5d ions, and plays a more important role than in the more familiar 3d-based magnetic materials. Geometric frustration, the B' ion sublattice is f.c.c., based on edge sharing tetrahedra, also is of critical importance. Observed magnetic ground states range from spin glasses (without apparent disorder), collective spin singlets, ferromagnets and antiferromagnets. Often, ordered moments are a small fraction of a Bohr magneton. Systematic behavior is elusive. For example Ba2YReO6 and Ba2CaOsO6 (both Fm-3m) have the same unit cell constant to within .01 % and both are based on 5d2 ions but the former is a highly unconventional spin glass and the latter orders antiferromagnetically below 50K. Recent results on this class of magnetic materials will be described in the context of existing theories.

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