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Magnetic frustration and random exchange in double perovskites

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The double-perovskite structure offers an exciting platform for studying novel magnetic properties. Here I present our recent results on the B-site ordered double perovskites Sr2Cu(Te,W)O6, which show low-dimensional magnetic properties and possible spin liquid –type behavior. The structure of these materials is three dimensional, but Jahn-Teller distortion and a subsequent orbital ordering results in an effective square lattice of the S = 1/2 Cu2+ ions.
The magnetic ground state in a square lattice depends on the ratio of the nearest neighbor (NN) and next-nearest neighbor (NNN) interactions, and with frustrated interactions, novel ground states such as spin liquids may be obtained. In Sr2Cu(Te,W)O6, the magnetic interaction are mediated through the O-Te/W-O bonds, and the choice of the second B-site cation dictates the magnetic properties: Te causes the NN interactions to be the strongest, while W results in NNN interactions dominating. Partial cation substitution leads to a random arrangement of Te and W on the second B-site, which results in random exchange pathways between the Cu ions. In the solid solution Sr2CuTe1-xWxO6, the combination of frustration and randomness of the magnetic interactions causes a complete suppression of long-range magnetic order.
The implications of the results on other double perovskite compounds are also discussed. It is a common feature in the A2B'B"O6 double-perovskite compounds that the choice of the non-magnetic B"-site cation can affect the magnetic interactions between the magnetic B' cations. This behavior combined with the random exchanges caused by a partial B"-site cation substitution is expected to result in many more interesting materials with suppressed magnetic ordering and novel ground states.
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