Experimental Realization of Low Dimensional Antiferromagnets

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The discovery of high-T_c superconductors has triggered a surge of interests in quantum spin liquids in low-dimensional Heisenberg antiferromagnets such as one-dimensional (1D) chains and two-dimensional layers, where local magnetic moments are strongly correlated yet evade a conventional long-range order (LRO) down to 0 K owing to strong quantum fluctuations.[1] However, a large-*S* system, in particular, is still difficult to realize experimentally because the presence of small but finite interactions between chains (or layers) readily results in LRO. Thus, to avoid LRO, it is essential to minimize *J'*/*J* (*J'* and *J* are inter- and intra-chain interactions, respectively), for which inorganic-organic hybrid materials with organic components acting as a bulky separator are promising.

In this presentation, we will introduce two strategies for synthesizing ideal 1D chains with large-*S*. The first strategy is topochemical dehydration/rehydration route to construct ideal 1D chains. A novel 1D chain antiferromagnet (2,2′-bpy)$FeF_3 \cdot 2H_2O$ (2,2′-bipyridine = 2,2′-bpy) with best 1D magnetism rationally was prepared by a controlled topochemical de/re-hydration approach from a hydrous precursor (2,2′-bpy)$FeF_3(H_2O) \cdot 2H_2O$ with isolated spins (S = 5/2).[2] In addition, this controlled topochemical de/re-hydration approach can be universally applied for other systems, for example, for successfully obtaining 1D S = 3/2 spin chain antiferromagnet (2,2′-bpy)$CrF_3 \cdot 2H_2O$ from the precursor (2,2′-bpy)$CrF_3(H_2O) \cdot 2H_2O$. The second strategy is utilizing long organic molecules for effectively separating spin chains to directly synthesize a series of ideal antiferromagnetic spin chain materials such as 1D S = 3/2 spin chain antiferromagnet Co(ox)(bib)$\cdot H_2O$ (ox = oxalate; bib = 1,4-bis(imidazole-1-yl)benzene)[3] and an nearly-ideal 1D spin S = 5/2 chain antiferromagnet (4,4'-bipyridyl)FeF_3 with best 1D magnetism.[4]

References

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