TOPICAL REVIEW

Variety of valence bond states formed of frustrated spins on triangular lattices based on a two-level system $Pd(dmit)_2$

Masafumi Tamura *et al* 2009 *Sci. Technol. Adv. Mater.* **10** 024304 (12pp) doi: 10.1088/1468-6996/10/2/024304 Help

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Abstract. Recent studies on the physical properties of the triangular system based on the $Pd(dmit)_2$ salts (dmit=1,3-dithiole-2-thione-4,5-dithiolate) are reviewed. Quantum chemical architectures of the $Pd(dmit)_2$ molecule and its dimer are introduced with emphasis on the strong dimerization of a two-level system, which provides unique physical properties of the salts. The magnetic properties are outlined in view of the magneto-structural correlation specific to the frustrated spin systems. Some newly discovered ground states and their origins are discussed, for which the valence bond formation plays a key role. Among them, the two-level structure is crucial for the novel charge-separated state found in two salts. The valence bond ordering, similar to the spin-Peierls transition, has been found in a two-dimensional frustrated spin system. The physical aspects and possible relation to the pressure-induced superconductivity are discussed.

Keywords: $Pd(dmit)_2$ salts, triangular lattice, antiferromagnets, frustration, HOMO-LUMO interplay, spin gap, superconductivity

Print publication: Issue 2 (April 2009)
Received 18 October 2008, accepted for publication 4 November 2008
Published 6 July 2009