Strongly correlated systems on highly frustrated lattices: From magnons to electrons

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For antiferromagnetic Heisenberg spin systems as well as for Hubbard electrons on various frustrated lattices a class of exact eigenstates can be constructed [1, 2]. Such eigenstates can be found, e.g., for the 1D sawtooth and kagome chains, the 2D kagome and checkerboard lattices, and the 3D pyrochlore lattices. The exact many-particle eigenstates consist of independent magnons (electrons) localized on finite areas of the lattice and become ground states for certain values of total magnetization (electron concentrations). Important structural elements of the relevant systems are triangles being attached to polygons or lines. Then the magnons (electrons) can be trapped on these polygons or lines. For electrons the scenario of localized eigenstates is related to the so-called flat-band ferromagnetism [2].

The correlated systems having localized eigenstates exhibit a highly degenerate ground-state manifold at the saturation field h_{sat} (at a characteristic value of the chemical potential μ_0) for magnons (electrons) [2, 3]. The degeneracy grows exponentially with the system size and leads to a finite residual entropy. By mapping the localized magnon (electron) degrees of freedom onto a hard-core lattice gas one may find explicit analytical expressions for the low-temperature thermodynamics in the vicinity of h_{sat} (μ_0). Though the scenario of localized eigenstates is similar for spin and electron systems, the different statistics of spins and electrons leads to different construction rules for the localized eigenstates and, as a result, to a different hard-core lattice gas description.

References

[1] J. Schulenburg et al, Phys. Rev. Lett. **88**, 167207 (2002)

[2] A. Mielke, J. Phys. A **24**, L73 (1991), O. Derzhko et al., Phys. Rev. B **76**, 220402(R) (2007); ibid. **81**, 014421 (2010).

[3] M. E. Zhitomirsky and H. Tsunetsugu, Phys. Rev. B 70, 100403(R) (2004); O. Derzhko and J. Richter, Phys. Rev. B **70**, 104415 (2004); M. Maksymenko et al., Eur. Phys. J. B **84**, 397 (2011).