INELASTIC LIGHT SCATTERING IN LOW DIMENSIONAL QUANTUM SPIN SYSTEMS

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We have studied electronic excitations from lower dimensional spin $S = 1/2$ systems with antiferromagnetic (AF) exchange correlations by means of inelastic light scattering. We focussed on magnetic scattering in the 1 - 500 meV energy range from one and two triplet excitations as well as on their symmetry and corresponding light coupling mechanism.

The data in $Sr_{14-x}Ca_xCu_{24}O_{41}$, which contain quasi-one dimensional (1D) two-leg ladder units, reveal a well defined two-magnon resonance at 370 meV whose spectral width and resonance properties are contrasted to its counterparts in 2D square lattices and the multi-spinon scattering from quasi-1D $S = 1/2$ AF chains. Low energy spectra from lightly doped two-leg ladders reveal characteristic electronic excitations out of a charge density ground state arising from many-body electronic interactions.

One-magnon excitations are observed in the quasi-2D antiferromagnetically ordered $La_{2-x}Sr_xCuO_4$ crystals. We map the anisotropic magnetic field dependence of the 2 mev spin-wave branch arising due to antisymmetric spin exchange and we are able to understand the data using a canonical form of the spin Hamiltonian. We observed magnetic field induced modes whose dynamics allowed us to discover a spin-flop like transition for field orientations perpendicular to the easy-axis.

Based on resonance properties and energy considerations we were able to identify in the 0 - 200 meV range a multi-spinon Raman continuum from the quasi-1D AF spin chains of NaV_2O_5 . At T = 10 K we observed one-magnon scattering whose the selection rules in external magnetic fields were explained in terms of the antisymmetric spin interaction and Fleury-Loudon type coupling.

The symmetry and light coupling mechanisms to elementary triplets and multi-particle bound states were the topics studied in $SrCu_2(BO_3)_2$. The analysis of a four spin cluster allowed us to propose a resolution of these problems for the real space localized elementary excitations and, again, the antisymmetric spin-exchange was suggested to play an important role in this case. Two distinct light coupling mechanisms were found responsible for the observed resonance behavior of the magnetic modes.