Talk 15: 14:00–

Exotic ESR modes of spin liquid states

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I will present experiments with frustrated and spin-gap antiferromagnetic systems. The frustrated pyrochlore antiferromagnet $Gd_2Ti_2O_7$ remains paramagnetic at the temperature T far below Curie-Weiss temperature Θ=10 K. In the molecular field approximation, due to a special geometry of exchange bonds, there is an infinite number of degenerate spin configurations with minimum energy. Correspondingly, a macroscopic number of local soft modes gives rise to a large entropy at $T \ll \Theta$. We tested these soft modes, at first, by a thermodynamic method, performing effective cooling via the adiabatic demagnetization. Further, we detected these modes by the magnetic resonance spectroscopy: a wide band of low-frequency microwave absorption with a minor energy gap was found at low temperatures. Another ESR problem of the frustrated systems is ESR of exotic ordered phases. Despite the fact that the exchange interaction can't stabilize a spin-ordered state, the ordering, however, occurs at $T = T_N \simeq 0.1\Theta$. It is due to weaker factors, like dipole-dipole interaction, fluctuations, single-ion anisotropy, etc. This ordering is accompanied by the reconstruction of the ESR spectrum: a three-branch resonance spectrum with two energy gaps appears below T_N, and the wide band is surviving. The observed three-branch spectrum is typical for noncomplanar exchange antiferromagnets. In contrast to conventional antiferromagnets, this ordered structure is soft in the exchange approximation, allowing additional low-frequency modes. This requires a new approach, aimed for the dynamics of ordered exchange-correlated systems without the exchange rigidity.

Collective triplet excitations in the dimer spin-gap magnet $TlCuCl_3$ and in the Haldane-like magnet $PbNi_2V_2O_8$ present another example of new kind of spin dynamics. In both cases the spectrum of triplet excitations was found to be temperature dependent, indicating a non-linear renormalization of the excitations energy or an interaction between the triplets. The 3D interdimer (interchain) coupling is known to allow the transition from a spin-liquid to an antiferromagnetic phase in a magnetic field, closing the spin gap. This ordering modifies the spectrum of triplet excitations both above and below the critical field. The measured spectrum of triplet excitations demonstrated a strong deviation from the perturbative approach for noninteracting chains.