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High frequency ESR study of the field induced gap on a ladder-like system $(C_5H_9NH_3)_2CuBr_4$

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Low-dimensional quantum spin systems have attracted much interest as one of the useful models for investigating strongly correlated quantum many body systems from both the theoretical and experimental points of view. In particular, the bosonization approach has been considered to describe the low energy physics in low dimensional spin systems. One of the most fascinating properties in low-dimensional system is the research of the low energy physics in zero temperature phase transition as in the case of two leg ladder materials. $S = 1/2$ antiferromagnetic two leg ladders have a finite gap at zero temperature. However, a gapless phase can appear when an external field is applied. The gapless phase is described by a one-component Tomonaga-Luttinger liquid (TLL) using the bosonization approach. Another low energy physics has been studied an unexpected magnetic field induced gap in the low-energy excitation spectrum of Cu-benzoate and $[Pyrimidine\text{-}Cu(NO_3)_2(H_2O)_2]_n$, quasi-one-dimensional spin chain materials. Such a system of the field induced gap can be successfully described by the quantum sine-Gordon (SG) field theory, in which an effective staggered magnetic field induces the gap. In the real system, the alternating g tensor and the Dzyaloshinskii-Moriya (DM) interaction in an external magnetic field are the candidate for the origin of the staggered field.

ESR measurements have been performed on poly crystal sample of a $S = 1/2$ Heisenberg antiferromagnetic ladder-like system $(C_5H_9NH_3)_2CuBr_4$. At high temperatures, a broad ESR absorption line has been observed. With decreasing the temperature below 10 K which corresponds the temperature of to the broad maximum of the susceptibility, we have observed the damping of the EPR intensity and the development of new resonance absorptions. The resonance field and the line width behaviors of ESR absorptions qualitatively correspond to the spinon and the breather excitation in Cu-benzoate.