Theory of electromagnon in noncollinear magnets

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We propose a new mechanism to induce a novel one-magnon excitation by the electric component of light in spins with noncollinear structures, where electric fields couple to spins through the symmetric spin-dependent electric polarizations $P_S = \Pi_{ij}(S_i \cdot S_j)$ [1,2].

One of the typical examples for noncollinear structures is a cycloidal spin structure, which is realized due to the frustration between nearest neighbor J_1 and next nearest neighbor interactions J_2 in classical spin systems. We adopt the mechanism to the three-dimensional frustrated Heisenberg systems (Fig.1), where cycloidal spin states are the ground state in highly frustrated parameter region, and show that the electromagnon at zone-edge can be induced by oscillating electric fields $E^\omega \| a$. Such a zone-edge magnon excitation corresponds to the absorption observed in multiferroic perovskite manganites $R\text{MnO}_3$ [2-8] and the selection rule, *i.e.*, the strong absorption is observed only for the condition $E^\omega \| a$, is also consistent with experimental observations. Some parts of optical spectra observed experimentally in DyMnO_3 [5] and TbMnO_3 [7] can be explained well as shown in the figures (Fig.2 for DyMnO_3 and Fig.3 for TbMnO_3).

Noncollinear structures can be realized due to the frustration generally and, thus, the absorption due to the electromagnon process likely exists in various frustrated materials.

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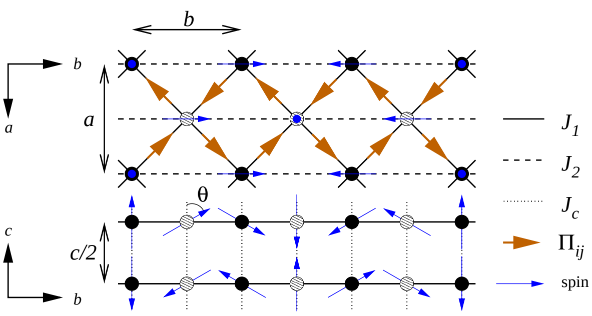
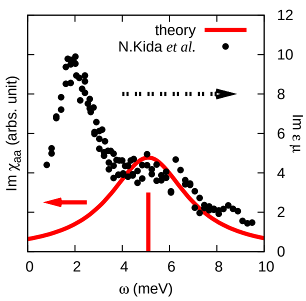


(1)



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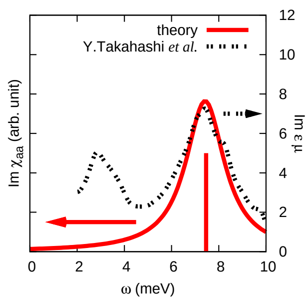

(3)