Vector spin chirality order and dynamical magnetoelectric effects in frustrated spin-1/2 chain systems

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We show by unbiased numerical calculations that in a frustrated spin-1/2 chain relevant to multiferroic cuprates including $LiCu_2O_2$ and $LiCuVO_4$, the ferromagnetic nearest-neighbor exchange interaction, which has been established by neutron-scattering experiments, stabilizes a vector spin chirality order and a quasi-long-range helimagnetic order against the quantum fluctuation. This explains why these multiferroic materials do not show a dimer ordering, which is expected in the case of the antiferromagnetic nearest-neighbor coupling. We also perform realistic semi-classical analyses for $LiCu_2O_2$ by taking into account interchain/Dzyaloshinskii-Moriya interactions. A reasonably nice agreement with overall experimental findings including neutron-scattering, NMR, and THz spectroscopy data has been found for a reasonable choice of coupling parameters. This resolves controversies on the helical magnetic structure of the material and unveils the pseudo-Nambu-Goldstone modes as the origin of experimentally observed electromagnons.
[S. Furukawa, M. Sato, and S. Onoda, Phys. Rev. Lett. 105, 257205 (2010).]