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EXACT DIAGONALIZATION ANALYSIS OF MAGNETIC BLOCH OSCILLATIONS

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We consider an Ising-like ferromagnetic spin-1/2 chain with *x-y-z* anisotropy in the presence of an external magnetic field:

$$H = \Sigma_j \left(J_z S^z_j S^z_{j+1} + J_y S^y_j S^y_{j+1} + J_x S^x_j S^x_{j+1} - g\, \mu_B\, H\, S^z_j \right)$$

It has been predicted by Kyriakidis and Loss[1], that in this system magnetic domain walls will perform oscillating behaviour, the so-called magnetic Bloch-oscillations. Several candidate materials, where magnetic Bloch oscillations should be observable, have been suggested. Neutron scattering experiments has been carried out on one of the candidates, $CoCl_2 \cdot 2D_2O$, without success [2,3].

We study the dynamics of domain walls in a system similar to $CoCl_2 \cdot 2D_2O$ by simulating a ferromagnetic Ising-like chain of spin s=1/2 in an external magnetic field. Only nearest neighbour interactions are considered and we apply periodic boundary conditions. We formalize mathematically the description of the physical system of spins to block-diagonalize the Hamiltonian belonging to the system. Afterwards we calculate the eigenvalues and the eigenstates of the lowest excitations using the subspaces defined by the block-diagonalization of the Hamiltonian and the Lanczos-algorithm. Furthermore we calculate the dynamical structure factor of the relevant transitions corresponding to magnetic Bloch oscillations.

Our results for the dynamical structure factor show clear signs of magnetic Bloch oscillations for systems with the ideal case $J^{xy} = (J^x+J^y)/2 = 0$. However, the stability of the magnetic Bloch oscillations depends sensitively on the value of J^{xy}. When J^{xy} becomes comparable to $J^a = (J^x-J^y)/2$, the magnetic Bloch oscillations are suppressed. This suppression becomes more pronounced with increasing system size, whence we do not expect it to be a finite-size effect. We propose that the J^{xy} term present in the $CoCl_2 \cdot 2D_2O$ system is responsible for the non-observance of magnetic Bloch oscillations in this compound.

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