Muon Spin Relaxation Studies of an 1/2 Spin Chain Compound $LiCu_2O_2$

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Recent discoveries of the remarkable cross-coupling effects in frustrated magnets, such as spectacular change of the dielectric constant with applied magnetic field and reversibly flipping ferroelectric polarization, offer new possibilities for multiferroic applications and new trends in understanding of the multiferroic fundamentals [1,2]. Multiferroics with enhanced cross-coupling effects exhibit magnetic order with broken central symmetry. The magnetic-field-induced ferroelectricity is believed to originate from the lattice relaxation through exchange striction associated with the magnetic order. The exchange striction causes that the exchange coupling between spins becomes a tensorial quantity with both the symmetric and antisymmetric parts. The antisymmetric parts which constitute the so-called Dzyaloshinskii-Moriya interaction give rize to ferroelectricity associated with spiral-magnetic order in several systems, like $TbMnO_3$, spinel $CoCr_2O_4$, $MnWO_4$ etc.

A spiral-magnetic order is realized when in a chain magnet the nearest neighbor FM coupling competes with the next-nearest-neighbor AFM coupling. Compound $LiCu_2O_2$ presents a typical example of 1D spiral magnet with competing FM and AFM interactions. However, both the nature of the magnetic order and the nature of the ferroelectricity in this material are matters of the considerable debate at the moment. in particular, recent experiments present inconsistent results on the magnetic order in $LiCu_2O_2$ [3,4].

Here we report our muon spin relaxation and magnetization (SQUID) studies of the crystalline $LiCu_2O_2$. We found 2 types of magnetic transitions in this compound.

[1] T. Kimura et al., Nature 426 (2003) 55.
[2] N. Hur et al., Nature 429 (2004) 392.
[3] T. Matsuda et al., Phys. Rev. Lett. 92 (2004) 177201.
[4] S. Park et al., Phys. Rev. Lett. 98 (2007) 057601.