Static magnetic order on the triangular antiferromagnet \( \text{Li}_x\text{NiO}_2 \) with \( x \leq 1 \)

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In the rhombohedral \( \text{LiNiO}_2 \) lattice with space group \( \text{R3m} \), the \( \text{NiO}_2 \) plane and the Li layers form alternating stacks along the \( c_H \)-axis in a hexagonal setting. In the \( \text{NiO}_2 \) planes, Ni ions form a two-dimensional triangular lattice (2DTL) by a network of edge-sharing \( \text{NiO}_6 \) octahedra. Since the 2DTL planes are separated by nonmagnetic Li layers and \( \text{Ni}^{3+} \) is in a low spin state \( (t^6_{2g}e^1_g) \) with \( S=1/2 \), \( \text{LiNiO}_2 \) is thought to be an ideal material for elucidating frustrated magnetism on a half-filled 2DTL. Thus far, there has been no long-range magnetic order detected down to the lowest \( T \) investigated, although the susceptibility (\( \chi \)) measurements show a spin-glass-like anomaly around 10 K. Both heat capacity and NMR measurements, however, suggest a spin-liquid state with short-range ferromagnetic (FM) correlations [1]. A \( \mu^+\)SR experiment has also indicated the absence of static magnetic order down to 2 K as well as showing the existence of fast fluctuating moments [2]. Recent neutron diffraction (ND) experiments have proposed the possibility of local orbital ordering of \( \text{Ni}^{3+} \) into three sublattices [3].

In order to gain elucidation upon the nature of the \( \text{NiO}_2 \) plane and solve the current confusing situation, we have investigated the variation of magnetism with the spin concentration on the 2DTL. For \( \text{LiNiO}_2 \), Li ions are known to be easily deintercalated by electrochemical reaction down to \( x \sim 0 \). Here, we report the microscopic magnetic nature of \( \text{Li}_x\text{NiO}_2 \) with \( x=1, 2/3, 1/2, 1/3, \) and 0.1 by means of \( \mu^+\)SR, and the existence of a variety of phases as a function of \( x \) in \( \text{Li}_x\text{NiO}_2 \). In particular, the appearance of static magnetic order, most likely IC-SDW order for \( \text{Li}_x\text{NiO}_2 \) with \( x=1 \) and 2/3, suggests the AF ground state of the \( \text{NiO}_2 \) plane.