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Honeycomb lattice spin-orbit Mott insulators[1]

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Iridates displaying a Mott insulating state caused by the interplay of electronic correlations and strong spin-orbit coupling have recently attracted considerable attention. We focus on the honeycomb material A_2IrO_3 (A=Na, Li), in which the topology of the underlying lattice leads to interesting magnetic properties [1]. The strong spin-orbit coupling in this 5d transition metal system is expected to result in orbital-dependent highly anisotropic magnetic in-plane exchange [2]. The combination of $J_{eff} = 1/2$ and the underlying honeycomb lattice makes A_2IrO_3 a promising candidate for the Kitaev model, which is exactly solvable and has a spin-liquid ground state. Our experimental data on Na_2IrO_3 prove a Mott insulating state of effective J=1/2 moments with predominant antiferromagnetic coupling, indicated by a Weiss temperature of $\theta = -120$ K. A bulk antiferromagnetic transition occurs at a much reduced temperature of $T_N = 15$ K and the reduced magnetic entropy suggests strong magnetic frustration and/or low-dimensional magnetic interactions. The nature of the ordered phase has also been studied by resonant x-ray spectroscopy near the Ir-L3 edge, providing evidence for an unconventional, most-likely zig-zag-type spin ordering [3]. The latter may be related to next-nearest neighbour exchange and/or a substantial Kitaev contribution in the Heisenberg-Kitaev model [2]. Upon replacing Na with the smaller Li, one may enhance the relative importance of the Kitaev contribution. For Mott insulating Li_2IrO_3 we observe a similar ordering temperature of 15 K, while the negative Weiss temperature is drastically reduced. These observations are compatible with an enhancement of the Kitaev contribution compared to the Na-system, suggesting that Li_2IrO_3 could be located close to the Kitaev limit [5].

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[1] Work in collaboration with Yogesh Singh and Soham Manni.