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Magnetism and Ferroelectricity in the frustrated spin chain compound Ca_3CoMnO_6 EUNDEOK MUN, J. KIM, M. JAIME, N. HARRISON, V. ZAPF, NHMFL, LANL, Los Alamos, NM 87545, Y. KAMIYA, C. BATISTA, T-division, LANL, Los Alamos, NM 87545, H. YI, Y. OH, S. CHEONG, RCEM and Dept. of Physics and Astronomy, Rutgers University, Piscataway, NJ 08854 — In many multiferroics, there is little or no net magnetism coupled to electric polarization. Ca_3CoMnO_6 is unusual among multiferroics since it has a net, hysteretic magnetization coupled to electric polarization, which is important for many applications. Thus, understanding the origin of the magnetic behavior and its coupling to the electric polarization is important. Up to now the arrangement of magnetic exchange interactions, the size of the Co spin, and the origin of magnetic hysteresis were not completely understood. We show magnetization, magnetostriction, electric polarization, and magnetocaloric effect data up to 100 T, including notably a 1/2 and a 2/3 plateau in the magnetization and non-monotonic magnetostriction behavior. We determine that the spin state of Co is definitely $\mathbf{S} = 3/2$ at both high fields and low fields. We show that this behavior is consistent with an ANNNI-like model with antiferromagnetic interactions in the hexagonal **ab-**plane, and ferromagnetic interactions along **c-**axis. The model takes into account Ising-like Co spins and Heisenberg-like anisotropic Mn spins. The evolution of the Ising-like Co spins accounts for the hysteresis and steps in the physical properties up to 20 T, and also produces a positive magnetostriction, whereas alignment of the Heisenberg-like Mn spins produce non-hysteretic behavior up to saturation at ∼85 T, as well as negative magnetostriction.

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