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Incommensurate modulated spin order and NMR wipeout effect in electron-doped manganites probed by 139La NMR

Hole doped transition metal oxides are famous due to their extraordinary charge transport properties, such as high temperature superconductivity (cuprates) and colossal magnetoresistance (manganites). Astonishing, the mother system of these compounds is a Mott insulator, whereas important role in the establishment of the metallic or superconducting state is played by the way that holes are self-organized with doping. Experiments have shown that by adding holes the insulating phase breaks into antiferromagnetic (AFM) regions, which are separated by hole rich clumps (stripes) with a rapid change of the phase of the background spins and orbitals. However, recent experiments in overdoped manganites of the La1−xCaxMnO3 (LCMO) family have shown that instead of charge stripes, charge in these systems is organized in a uniform charge density wave (CDW). Nuclear Magnetic Resonance (NMR) has been a powerful local probe for a static and dynamic investigation of magnetic states due to the distribution of local magnetic fields in the sample via hyperfine interactions. In 139La NMR the lanthanum nucleus (I=7/2) directly exhibits the magnetic state (FM or AF) of the nearest manganese ions neighbors. Here, by using 139La NMR we provide direct evidence that the ground state of overdoped LCMO is indeed solitonic. By lowering temperature the narrow NMR spectra observed in the AFM phase are shown to wipe out, while for T < 30K a very broad spectrum reappears, characteristic of an incommensurate (IC) charge and spin modulation. Remarkably, by further decreasing temperature, a relatively narrow feature emerges from the broad IC NMR signal, manifesting the appearance of a solitonic modulation as $T \rightarrow 0$.

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