Strong interlayer magnetic exchange coupling in La3Ni2O7-δ revealed by inelastic neutron scattering

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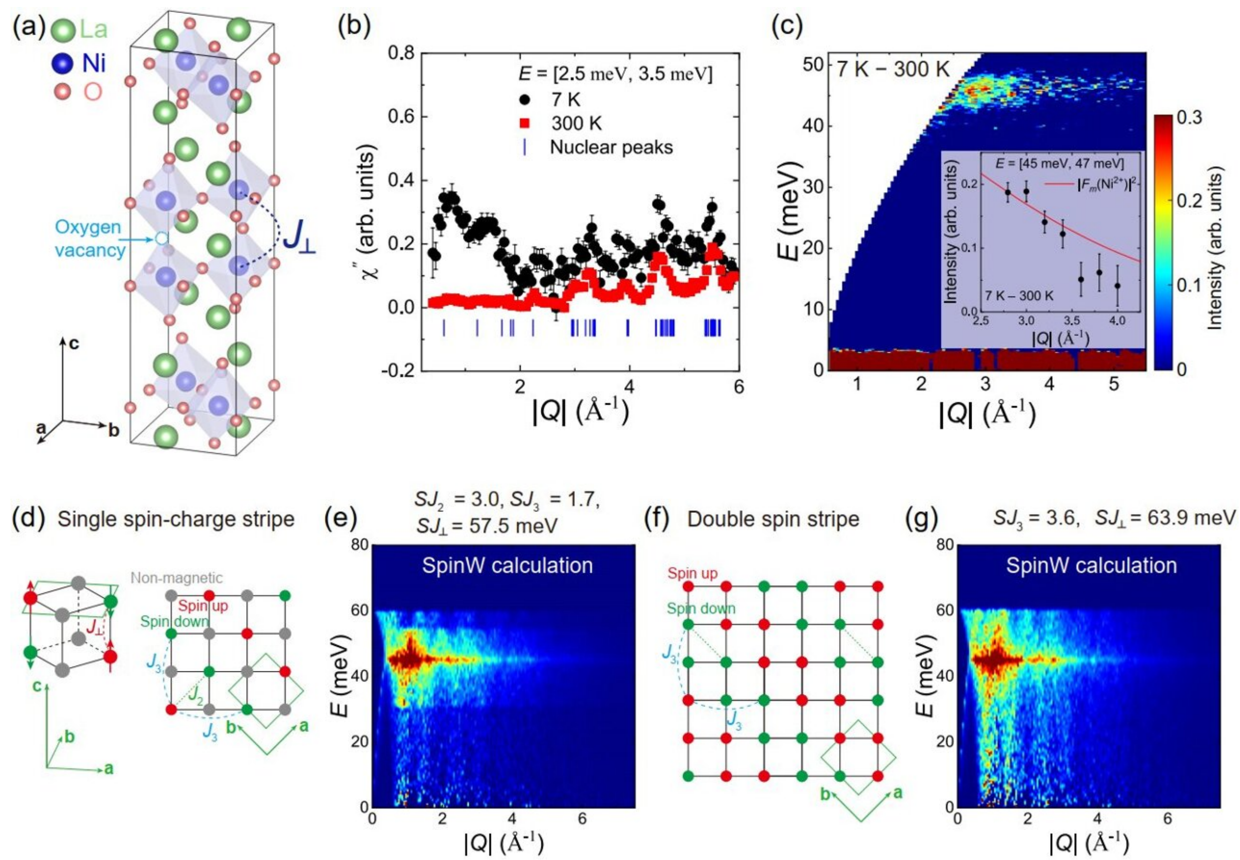

The lattice structure and spin excitation spectra of powder $La_3Ni_2O_{7-\delta}$ a The lattice structure of $La_3Ni_{2}O_{7-\delta}$ b The momentum dependence of the dynamical susceptibility χ'' within *E* = [2.5, 3.5] meV; c The subtraction of the low- and high-temperature spin excitations d and e The schematic of single spin-charge stripe AFM order and the calculated spin-excitation spectrum from SpinW with SJ_2 = 3.0, SJ_3 = 1.7, and $SJ_\perp$ = 57.5 meV f and g The schematic of double spin stripe AFM order and the calculated spin-excitation spectrum from SpinW with $SJ_3 = 3.6$, and $SJ_\perp = 63.9$ meV. Credit: Science China Press

Recently, an inelastic neutron scattering work on the bilayer nickelate $La_3Ni_2O_{7-\delta}$ polycrystal finished by a team from Sun Yat-sen University was published in *Science Bulletin*. The team employed neutron spectroscopy to study the magnetic ground state and spin dynamics of $La_3Ni_2O_{7-\delta}$ at ambient pressure.

The neutron diffraction results show that there is no magnetic order down to 10 K. In the inelastic channel, they observed some weak spin excitations, which contain low-energy spin excitations at several millielectronvolts and almost non-dispersive high-energy spin excitations around 45 meV. These results can be explained to be from strong interlayer and weak intralayer magnetic couplings of stripe-type antiferromagnetic orders. The corresponding interlayer and intralayer magnetic couplings could be around 60 meV and 3~4 meV, respectively.

These observations are quite different from that in cuprate and iron-based superconductors, which have dominant intralayer exchange couplings. To date, there are still a lot of debates about the high-T_c mechanism in nickelates, but the consensus of most existed theories is that interlayer magnetic couplings play a key role. The super exchanges between two adjacent nickel layers are mediated by the apical oxygens, whose vacancies can break the interlayer couplings directly, and further break the pressure-induced high-T_c superconductivity.

Thus, this work not only studies the spin excitations of $La_3Ni_2O_{7-\delta}$ at ambient pressure, determines the unique magnetic couplings in bilayer nickelates, but also provides crucial experimental evidences for understanding the high-T_c mechanism and the role of apical oxygens.

More information: Tao Xie et al, Strong interlayer magnetic exchange coupling in La3Ni2O7− revealed by inelastic neutron scattering, *Science Bulletin* (2024). DOI: 10.1016/j.scib.2024.07.030

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