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Magnetic and Charge Density Wave Order in La3Ni2O7, La2PrNi2O7, and La4Ni3O10 as a Function of Pressure and Oxygen-Isotope Substitution

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Recently, bulk superconductivity has been observed in the layered nickelates $La_3Ni_2O_7$ and $La_4Ni_3O_{10}$ under hydrostatic pressure, with transition temperatures of up to 80 K. At ambient pressure, these compounds exhibit intertwined and non-trivial spin-density wave (SDW) and charge-density wave (CDW) orders.

In this work, we present a detailed investigation [1, 2] of the structural, electronic, and magnetic properties of three members of the nickelate family - $La_3Ni_2O_7$, $La_2PrNi_2O_7$, and $La_4Ni_3O_{10}$ - as a function of pressure and oxygen-isotope substitution. Using a combination of μSR, resistivity, specific heat, neutron and x-ray diffraction measurements, we identify CDW, SDW as well as spin reorientation transitions.

Notably, the coupling between charge and spin degrees of freedom varies across the different compounds. Oxygen-isotope substitution selectively affects the coupled SDW and CDW states, highlighting the significant role of magnetoelastic coupling in these materials.

For all compounds, we propose distinct types of complex SDW orders and estimate the ordered moment sizes using DFT+μ calculations in conjunction with magnetic dipole field simulations.

[Fig 1: Our phase diagrams demonstrate the difference in coupling between CDW and SDW orders][fig1]

Figure 1 can be found here: https://drive.switch.ch/index.php/s/y4JH92wtE8tpBOb

[1] R. Khasanov et al., Nat. Phys. 21,430 (2025), arXiv:2503.04400, arXiv:2503.06560, arXiv:2504.08290
[2] I. Plokhikh et al., arXiv:2503.05287

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