Discovery of Giant Unit-Cell Super-Structure in PrNiO2

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A longstanding challenge regarding spectacular quantum phenomena such as high-temperature superconductivity in the cuprates is to – by design – realize similar physics in other materials. The discovery of superconductivity in infinite layer nickelates [1-3] has therefore sparked immediate excitement. A crucial characteristic of cuprates is the presence of two-dimensional charge order in the superconducting phase. Recently, a similar broken symmetry state – associated with charge order – has been revealed by resonant x-ray scattering in nickelates [4-6]. However, the interpretation of these results is surrounded by controversy and new studies propose that oxygen diffusion could lead to the observed superstructure [7].
To gain new insights into the nature of the observed superstructure, we performed high-energy grazing-incidence x-ray diffraction on thin films of PrNiO2. We demonstrate, for the first time, how in-situ high temperature annealing of the thin films induces a giant unit-cell superlattice structure with a rare period-six in-plane and a period-four out-of-plane symmetry [8]. The stability of this superstructure suggests a connection to an energetically favorable electronic state of matter, possibly providing a new pathway – different from Moiré structures – to ultra small Brillouin zone electronics.

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