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Machine Learning Correlates Charge Density Wave with the Local Gap in Cuprate Superconductors KAYLIE HAUSKNECHT, TATIANA WEBB, Harvard University, MICHAEL BOYER, Clark University, YI YIN, Zhejiang University, TAKESHI KONDO, University of Tokyo, TSUNEHIRO TAKEUCHI, Toyota Technological Institute, HIROSHI IKUTA, Nagoya University, ERIC HUDSON, Pennsylvania State University, JENNIFER HOFFMAN, Harvard University — With the advent of atomic resolution imaging techniques comes the challenge of disentangling the intrinsic electronic properties of materials from their stochastic atomic-scale disorder. In the past decade, machine learning (ML) image analysis techniques have rapidly evolved, while their applications in physics are just emerging. Here, we use ML to test local correlation hypotheses between spatially resolved measurements of disordered materials to overcome the limitations of standard Fourier analysis techniques. By training on a simulated density wave (DW) dataset, we develop a convolutional neural network (CNN) to uncover the doping-dependence of the DW in the cuprate superconductor $(Pb,Bi)_2(Sr,La)_2CuO_{6+}$ (Bi-2201) imaged via scanning tunneling microscopy. In Bi-based cuprates, the electronic inhomogeneity, caused by local variations in doping, limits the precision with which the DW wavevector can be measured. Our ML algorithm overcomes this limitation and allows clear differentiation between commensurate and incommensurate DW instabilities with physically distinct mechanisms. More broadly, our work lays the foundation for a ML approach to quantify intrinsic periodic order and correlations in datasets where these trends are masked by disorder.

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