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Spatial complexity in correlated electronic systems[1]

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There is growing experimental evidence that many strongly correlated electronic systems such as vanadium oxides, cuprates, and nickelates (among others) exhibit nano- and meso-scale variations in the local electronic properties. The interplay of many degrees of freedom and strong correlations can lead to competing electronic phases. In the environment of a host crystal, disorder can act as nucleation points for these competing states, leading to spatial complexity and multiscale pattern formation.[1] Rapidly expanding experimental capabilities have led to a growing wealth of data on multiple length scales, revealing rich electronic textures at the nanoscale and mesoscale in many correlated oxides. We have developed a new conceptual framework for interpreting the wealth of spatial information contained in the geometric properties of these textures.[2,3] By importing geometric cluster analysis techniques from disordered statistical mechanics, we identify universal scaling properties of the spatial complexity in strongly correlated materials. Because of the long equilibration times associated with these patterns, we expect glassiness and hysteresis effects to be prominent in strongly correlated systems with competing phases.[4] [1] E. Dagotto, Science 309, 257 (2005). [2] B. Phillabaum et al., Nature Commun. 3, 915 (2012). [3] S. Liu et al., Phys. Rev. Lett. 116, 036401 (2016). [4] E. W. Carlson and K. A. Dahmen, Nature Commun., 2, 379 (2011).

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