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Emergent Electronic and Phonon Modes from Correlated Disorder

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Disorder in crystals is often far from random, and in some cases the local correlations of disorder can be controlled. It is shown how crystals with identical average crystal structures, but different types of correlated disorder can have different electronic and phonon band structures. It is further shown that by changing the type of disorder from random to correlated, it is possible to open band gaps and tune the delocalization of modes, allowing for drastic changes to electronic properties. Bragg diffraction patterns are not enough to identify a structural phase when disorder is at play, as phases with widely different properties can have identical Bragg diffraction intensities. Diffuse scattering is needed to identify phases with disorder. Control over correlated disorder allows a new handle for tuning materials properties.

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