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Disorder is both friend and foe to melting of Wigner-Mott insulators

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Wigner crystals are extremely fragile, which is shown to result from very strong geometric frustration germane to long-range Coulomb interactions. Physically, this is manifested by a very small characteristic energy scale for sheer density fluctuations, which are gapless excitations in a translationally invariant system. The presence of disorder, however, breaks translational invariance, thus suppressing gapless excitations and pushing them to higher energy. We illustrate this general principle by explicit microscopic model calculations, showing that this mechanism very effectively stabilizes disordered Wigner lattices to much higher temperatures and densities, then in the clean limit. On the other hand, we argue that in two dimensions disorder significantly "smears" the melting transition, producing spatial coexistence of solid-like and liquid-like regions - just as recently observed in STM experiments. Our results paint a new physical picture for for melting of Wigner-Mott solids in two dimensions, corresponding to a Mott-Hubbard model with spatially varying local electronic bandwidth.

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