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**Super-resolution microscopy of cold atoms in an optical lattice** JONATHAN TRISNADI, MICKEY MCDONALD, KAI-XUAN YAO, MINGJIAMEI ZHANG, CHENG CHIN, James Franck Institute, Enrico Fermi Institute, and Department of Physics, University of Chicago — Super-resolution microscopy has revolutionized the fields of biology and chemistry by resolving features at the molecular level. In atomic physics, the ability to image atomic density distributions beyond the diffraction limit can play a key role in investigating lattice models with non-trivial spatial features, including Hubbard models with higher-occupied orbitals, Fermion-pairing at the BCS-BEC crossover, and atomic micromotion in Floquet lattice systems. Here we demonstrate super-resolution imaging based on the nonlinear response of atoms to spatially-varying optical pumping light. With this technique we achieve a FWHM resolution of 32(4) nm, a localization precision below 500 pm, and a temporal resolution of 1.4 $\mu$s. A byproduct of our scheme is the emergence of large mm-scale moiré patterns, which we show to be immensely-magnified images of the single-site density distribution. Finally, we report progress on our development of a Quantum Matter Synthesizer which combines quantum gas microscopy with single-site addressing via optical tweezers.

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