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High Orbital Exciton-Polariton Condensates in Two-Dimensional Lattices

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Microcavity exciton-polaritons are hybrid quantum quasi-particles as admixtures of cavity photons and quantum-well excitons. The inherent light-matter duality provides experimental advantages to undergo a phase change to condensation at high temperatures (e.g. 4-10 K in GaAs and room temperatures in GaN materials) due to the extremely light effective mass and stimulated scattering processes, and the dynamical nature in the open-dissipative condition allows us to control orbital symmetries of condensates. We have engineered two-dimensional polariton-lattice systems for the investigation of exotic quantum phase order arising from high orbital bands. Via photoluminescence signals in both real and momentum coordinates, we have observed *d*-orbital meta-stable condensation, vortex-antivortex phase order, linear Dirac dispersion, and flattened band structures in square, honeycomb, triangular and kagome lattices respectively. We envision that the polariton-lattice systems will be promising solid-state quantum emulators in the quest for understanding strongly correlated materials and in the development of novel optoelectronic devices.