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Vortex-lattice phase order in a microcavity exciton-polariton lattice system

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Microcavity exciton-polaritons are bosonic quasi-particles in microcavity-quantum-well structures, exhibiting spontaneous coherence to form condensates. We have engineered two-dimensional polariton-lattice systems for investigating quantum phase order associated with high-orbital symmetry. In particular, we have observed two-degenerate vortex-antivortex lattice order at the inequivalanet K and K$'$ points in the honeycomb lattice. Under the inversion symmetry, we identify the handedness of the vortex-antivortex phase order via an interferometry technique, which leads the quest for the nature of degenerate condensates at non-zero momentum values. We envision that the polariton-lattice systems will provide exciting opportunities to explore new quantum order arising from the interplay of topology, spin, orbital and various symmetry properties. We embark on a journey to deepen our understandings in quantum nature and to develop its novel applications.