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Fractional Quantum Hall Physics in Materials Made of Light

CLAIRE BAUM, NATHAN SCHINE, TIAN-XING ZHENG, NINGYUAN JIA, LOGAN W. CLARK, JONATHAN SIMON, University of Chicago — Ordinarily, photons do not interact with each other. However, atoms can be used to mediate photon-photon interactions, raising the prospect of forming synthetic materials and quantum information systems from photons. By dressing photons with atomic Rydberg states, we create strongly interacting Rydberg polaritons whose spatial profiles are determined by the modes of an optical cavity. Polaritons in a single spatial mode exhibit their strong interactions via blockade, an effect in which only one photon can transmit through the cavity at a time. Enabling these polaritons to move between multiple spatial modes of the optical cavity allows the polaritons to order themselves into strongly-correlated states. We present the initial experiments using Rydberg polaritons in a carefully tailored set of cavity modes to study strongly-correlated materials made of photons such as Laughlin states, the ground states of a fractional quantum Hall system.

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