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Rydberg Polariton Blockade in a 0D Photonic Quantum Dot NINGYUAN JIA, NATHAN SHINE, ALEX GEORGAKOPOULOS, ALBERT RYOU, Univ of Chicago, ARIEL SOMMER, MIT, JONATHAN SIMON, Univ of Chicago, SIMONLAB TEAM — Rydberg electromagnetically induced transparency (rEIT) is an emerging approach to mediate strong interactions between individual optical photons. To date, experimental investigations of this physics have employed freely propagating light-fields coupled to Rydberg-dressed atomic ensembles. Here we enhance the light-matter coupling by trapping the light field within an optical resonator, providing the photons with more time to interact with one another, and requiring substantially lower densities of cold atoms. Furthermore, working with a non-degenerate optical resonator allows us to directly realize a blockaded 0-dimensional photonic quantum dot whose properties we then explore. We observe a spectrally narrow dark-polariton resonance up to extremely-high Rydberg states (n˜121), and demonstrate strong photon-photon interactions within the dot through strong blockade of cavity transmission, demonstrated through anti-bunching of the transmitted field. By combining this breakthrough with degenerate-cavity realizations of tunable 2D photonic puddles that we have developed in parallel, this work points the way to explorations of crystalline and topological quantum materials composed of cavity Rydberg polaritons.

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