Always-on, highly efficient microwave photodetector based on a superconducting artificial molecule

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Efficient single-photon detection in the microwave regime is a missing piece in the toolbox of microwave quantum optics. However, its realization has proved challenging, due to the low energies involved. Some of the most promising implementations to date utilize superconducting circuits. Information on photon arrival during a detection window is mapped onto the state of a superconducting qubit, which is subsequently read out. These schemes, however, impose a tradeoff between duty cycle and detection efficiency. Here, by contrast, we demonstrate always-on detection of single microwave photons using a superconducting artificial molecule composed of two transmon qubits. Photons impinging on a bright state of the molecule are transferred to a dark state via with a driven-dissipative process. Photon "clicks" are revealed as quantum jumps in the continuously monitored dark state. In a first-generation device, we demonstrate cyclic detection with more than 80% efficiency and always-on detection with 50% efficiency across a 5 MHz instantaneous bandwidth. We envisage our detector to find applications in quantum state tomography, quantum thermodynamics, remote entanglement protocols, dark matter candidate searches, and fluorescence sensing.