Darkened collective mode probed with Autler-Townes splitting in a superconducting artificial molecule

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We experimentally investigated the quantum optics of two strongly coupled tunable transmon atoms, forming an artificial molecule with a frequency of about 4.5 GHz. Such a system represents an ideal 2-body system characterized by the transmon energy difference $ε$ and the inter-transmon coupling energy, *J*=300 MHz. By employing a readout resonator coupled to the molecule, we dispersively probed its energy spectrum and observed the avoided crossing of single transmon levels near the degenerate point *ε*=0. Based on the transmission data, we observed that the lower energy branch exhibits weak response to the driving microwaves, resulting in a darkened collective mode. To investigate the dependence of the darkened transition on $ε$, we utilized Autler-Townes splitting (ATS) to probe the Rabi frequencies induced by an external driving. Our results clearly demonstrate that the ATS for the upper branch bright mode is unaffected by $ε$. In contrast, the splitting displays a pronounced $ε$ dependence, increasing as $ε$ increases. Additionally, we conducted an analysis of the relaxation time T1 for the lower branch mode as a function of *ε*, revealing that T1 is longer at the degenerate point. This observation suggests enhanced protection of the darkened mode against external driving, which holds promising potential for applications in quantum information processing.