Josephson-junction quantum systems in open 1D space

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A superconducting quantum system (artificial atom) coupled to a transmission line is a direct analog of a natural atom in the open space. An important feature of the system is strong coupling to the 1D open space, which is experimentally observed as nearly 100% scattering of resonant radiation. This is theoretically possible but difficult to achieve for the natural atom. We use the artificial atom strongly coupled to the 1D space to demonstrate a series of basic quantum optical phenomena such as resonant fluorescence in elastic and inelastic scattering, anomalous dispersion, nonlinear properties of the two-level system. Using upper levels, we also demonstrate quantum optical effects on the three-level atom (textbook system of quantum optics), namely, electromagnetically induced transparency and quantum amplifier on a single atom. Having full coherent control of our atom by microwave pulse technique applied through the same transmission line, we demonstrate manipulation and dynamics of the atomic quantum states. We suggest an algorithm and perform derivation of two-time correlation function of fluctuations by measuring only coherent dynamics of the atomic emission.