

Two-body quantum energetics: the case of waveguide quantum electrodynamics

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We analyze the nature of energy exchanges between two coupled, but otherwise isolated, quantum systems. We define work as the component stemming from effective unitary interactions performed by each system on one another. The remainder of the energy is stored in the correlations and generally prevents full energy extraction by local operations. Focusing on the general scenario of a qubit coupled to the light field within a waveguide, we establish a bound relating work exchange and local energy extraction when the light statistics is coherent, that gets violated in the presence of a quantum light pulse. Our results provide operational, energy-based witnesses to probe non-classical resources.