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Quantum Nonlinear Optics without real Photons. VINCENZO MACRÍ, Univ. of Messina, Italy, ANTON FRISK KOCKUM, ROBERTO STASSI, RIKEN, Japan, OMAR DI STEFANO, SALVATORE SAVASTA, Univ. of Messina, Italy, FRANCO NORI[1], RIKEN, Japan — We propose a physical process analogous to spontaneous parametric down-conversion, where one excited atom directly transfers its excitation to a couple of spatially-separated atoms with probability approaching one. The interaction is mediated by the exchange of virtual, rather than real, photons. This nonlinear optical process is coherent and reversible, so that the two excited atoms can transfer back the excitation to the first one: the atomic analogue of sum-frequency generation. The parameters used here correspond to experimentally-demonstrated values in circuit QED. This approach can be extended to consider other nonlinear interatomic processes, e.g. four-qubit mixing, and is an attractive architecture for the realization of quantum devices on a chip.

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