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**N-Photon Wavepackets Interacting with an Arbitrary Quantum System**[1] BEN Q. BARAGIOLA, ROBERT L. COOK, Center for Quantum Information and Control, University of New Mexico, AGATA M. BRANCZYK, Department of Physics and Centre for Quantum Information and Quantum Control, University of Toronto, JOSHUA COMBES, Center for Quantum Information and Control, University of New Mexico — Traveling nonclassical states of light are important resources for quantum metrology, secure communication, and quantum networks. Motivated by this, we derive master equations for an arbitrary quantum system (e.g. a quantum harmonic oscillator or a multi-level atom) interacting with a wavepacket of light prepared in an N-photon Fock state. We then generalize this to N-photon states with arbitrary spectral distribution functions and wavepackets in two polarization (or spatial) modes. Our method also allows the calculation of output field quantities. As an illustration of our formalism, we explore the strong coupling regime for an atom in free space and investigate the scattering of Fock states from a two-level atom.

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