Semi-Classical and Quantum-Field Descriptions for the Non-Linear Electromagnetic Response of Many-Electron Systems[1] VERNE JACOBS, Naval Research Laboratory — Semi-classical and quantum-field descriptions for the non-linear electromagnetic response relevant to resonant pump-probe optical phenomena in quantized many-electron systems are formulated within a general reduced-density-matrix framework. Time-domain (equation-of-motion) and frequency-domain (resolvent-operator) formulations are developed in a unified and self-consistent manner. A preliminary semi-classical perturbation treatment of the electromagnetic interaction is adopted, in which the electromagnetic field is described as a classical field satisfying the Maxwell equations. It is emphasized that the development of a quantized-field approach will be essential for a fully self-consistent quantum-mechanical formulation. Compact Liouville-space operator expressions are obtained for the general (n'th order) non-linear electromagnetic-response tensors describing moving many-electron atomic systems. The tetradic matrix elements of the Liouville-space self-energy operators are evaluated for environmental collisional and radiative interactions.

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