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Semi-Classical and Quantized-Field Descriptions of Light Propagation in General Non-Local and Non-Stationary Dispersive and Absorbing Media[1] VERNE JACOBS, Naval Research Laboratory — Semi-classical and quantum-field descriptions for the interaction of light with matter are systematically discussed. Applications of interest include resonant pump-probe optical phenomena, such as electromagnetically induced transparency. In the quantum-mechanical description of matter systems, we introduce 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, using a Liouville-space operator representation. In the semi-classical description, the electromagnetic field is described as a classical field satisfying the Maxwell equations. Compact Liouville-space operator expressions are derived for the linear and the general (nth order) non-linear electromagnetic-response tensors describing moving many-electron systems. The tetradic matrix elements of the Liouville-space self-energy operators are evaluated for environmental collisional and radiative interactions. The quantized-field approach is essential for a fully self-consistent quantum-mechanical description.

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