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Propagation of light through spatially homogeneous yet non-stationary and non-Hermitian media

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We explore the propagation of light through a spatially homogeneous yet non-stationary and non-Hermitian media within the framework of classical electrodynamics. For an absorbing medium, especially, a generalized wave equation is derived for the electric displacement in terms of the complex dielectric permittivity of the medium. An analytically exact solution to this equation for finite transition period τ in terms of the hypergeometric function is determined for phenomenologically realistic, sigmoidal changes of the real and imaginary parts of the dielectric constant. Using this solution, we show that the energy of the light wave is not conserved, it is either increased or decreased, i.e. the wave is either amplified or attenuated, depending on the particular relation of dielectric permittivities. An interpretation of this wave phenomenon similar to the work by Feynman and Stueckelberg for the propagation of anti-particles is given on the one hand, and the energy exchange between the wave and medium analogous to the gain-loss asymmetry in non-Hermitian optics is explained on the other hand.