Quantum Theory of Interband Faraday and Voigt Effects*

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Abstract

A quantum-mechanical analysis of the Faraday rotation and the Voigt effect has been carried out for both the oscillatory and long-wavelength regions. Expressions have been developed for these effects from the off-diagonal and diagonal components, respectively, of the conductivity tensor; the latter has been obtained in the form of the Kramers-Heisenberg dispersion relations through the use of first-order time-dependent perturbation theory. The results, which have been calculated for a simplified two-band model, are generalized to apply in the high-field case as well as the low-field limit. Through the introduction of a phenomenological relaxation time, τ, line shapes have been calculated for both the direct and indirect transition for the Faraday and Voigt effects. These have been obtained as a function of frequency for various values of magnetic field and relaxation times. The results obtained enable the evaluation of g factors from experimental line shapes.

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