Five lecture

Kerr modulator The optical frequency Kerr effect

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Kerr modulator The optical frequency Kerr effect

Definition: a nonlinear interaction of light in a medium with an instantaneous response, related to the nonlinear electronic polarization

More general term: optical nonlinearities

Kerr Electro-optic Effect (DC Kerr Effect)

In this context, one considers a slowly varying electric field, which is applied to some medium, e.g. to a piece of glass using two electrodes. A light beam passing the glass can then experience a polarization-dependent change of optical phase which is proportional to the square of the voltage applied to the electrodes, i.e., to the square of the electric field strength. The polarization dependence implies that birefringence is induced even in an optical material which is naturally not birefringent. Subsequently, the considered piece of glass could be used as an electrically controllable waveplate.

Assuming a constant electric field strength over some path length L, the field-induced phase change is

$$\Delta\varphi = \frac{2\pi}{\lambda} L\Delta n = 2\pi KL E^2$$

where Δn is the difference in refractive index between two polarization directions (parallel and perpendicular to the electric field direction), K is the Kerr constant of the material and E is the applied electric field strength.