Department of Physics
University of Paderborn

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Exercise

Computational Optoelectronics and Photonics

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PROBLEM SHEET V

Please prepare by next exercise.

6. **Linear Absorption of a TLS**

The linear p-equation of a two-level system is given by

$$\frac{\partial}{\partial t}p = -i\omega_R p + \frac{i}{\hbar}\mu E - \gamma_p p \,. \tag{4}$$

(a) Solve Eq. (4) *analytically* for the driving electric field

$$E(t) = E_0 \delta(t) \,. \tag{5}$$

(b) Calculate $P(\omega)$ from $P(t) = \mu(p + p^*)$, neglect the off-resonant term and determine the absorption $\alpha(\omega)$.

(c) Now, solve Eq. (4) *numerically* using the 4th-order Runge Kutta method. Typical parameters are

$$\hbar\omega_R = 1.5\text{eV}\,, \tag{6}$$

$$\mu = 3\text{e}\text{Å}\,, \tag{7}$$

$$\gamma_p = 1.0 \cdot 10^{12}\text{s}^{-1}\,, \tag{8}$$

and $\Delta t = 5$fs for the excitation (gaussian) pulse. Write two files which contain $P(t)$ and $E(t)$.

(d) From (6c) calculate $P(\omega)$, $E(\omega)$, and $\alpha(\omega)$. Prove by a comparison with (6b) that your code works properly.

$$\alpha(\omega) = \frac{\omega}{c\,n(\omega)}\text{Im}(\chi(\omega)). \tag{9}$$

(e) What happens if you increase/decrease $\hbar\omega_R$? What if you increase/decrease γ_p?