Laser Physics I (Physics 464)
Homework II, due Monday, September 14, 2026

1 Shortest possible pulse

The shortest physically possible pulse should have its spectrum composed of positive frequencies. That excludes Gaussian and secant hyperbolic shaped pulses that extend from $-\infty$ to $+\infty$. A triangular pulse (Fig. 1) with its Fourier transform extending from 0 to $2\omega_0$ is theoretically possible. ω_0 is the central average (angular) frequency corresponding to the wavelength of 800 nm.

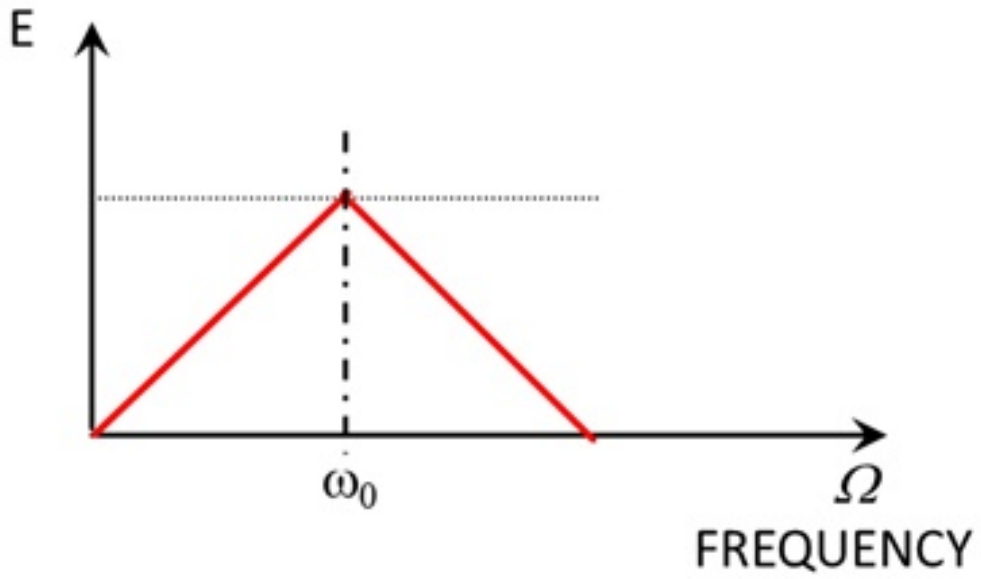

Figure 1: Spectral amplitude of an ultrashort pulse.

1. Find the temporal shape $E(t)$ of this pulse

Use properties of the Fourier transform.

2. Decompose the field in amplitude and phase factor at the central frequency

It is propagating in a medium with index of refraction

$$n = n_0 + a\Omega$$

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- Can you define a group velocity?
- Using Maxwell's equation reduced to first order, how does this pulse propagate?
- Numerical example: $a = \frac{1}{20\omega_0}$

3. Propagate the pulse using the second order Maxwell propagation equation