HYPERBOLIC-SECANT PULSES

Even if pulses emitted from many lasers can be approximated by a chirped Gaussian shape, it is necessary to consider other pulse shape. Of interest is the hyperbolic secant pulse shape that occurs in the context of optical solitons and pulses emitted by high-performance mode-locked lasers.

The optical envelope associated with such pulses usually takes the form:

$$F(0,t) = \operatorname{sech}\left(\frac{t}{t_0}\right) \exp\left(-\frac{iCt^2}{2t_0^2}\right) \quad (21)$$

where the chirp parameter C controls the initial phase (similarly to chirped gaussian pulses).

The transmitted envelope $F(z,t)$ is obtained by using Eq (5), Eq(6) and Eq. (21).

unfortunately, this time, it's not easy to solve the integral in Eq (5) in a closed form for non-gaussian pulses. Thus we can not derive explicit analytical expression.

we have to calculate exploiting numerical simulations.

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A comparison with the gaussian case shows that the qualitative features of dispersion induced broadening are nearly identitical for the Gaussian and secant pulses.

Note that T_0 appearing in Eq. (21) is not the FWHM but we have

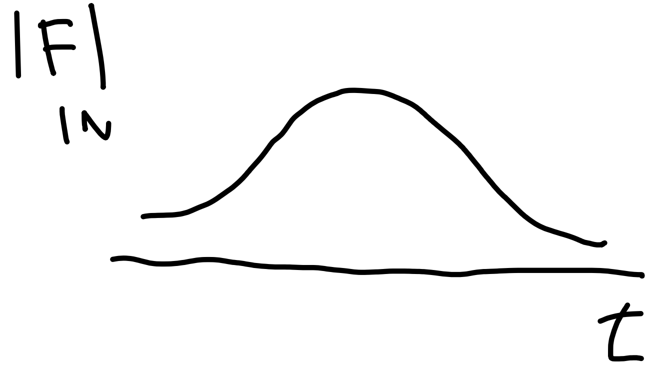
$$t_{FWHM} = 2\ln\left(1+\sqrt{2}\right) t_0 \simeq 1.76\, t_0 .$$

SUPER - GAUSSIAN PULSES

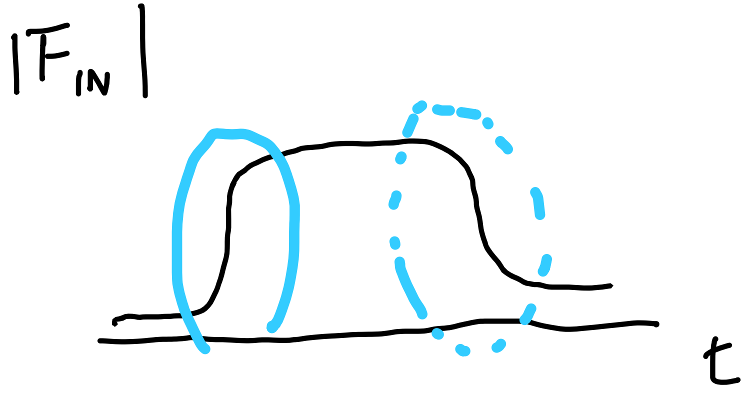
Up To now we have considered pulses with relatively broad leading and trailing edges. As one may expect, dispersion induced broadening is sensitive to pulse edge stepness. In general, a pulse with steeper leading and trailing edges broadens more rapidly with propagation simply because such a pulse has a wider spectrum to start with.

Pulses emitted by directly modulated semiconductor lasers fall in this category and cannot generally be approximated by a gaussian or secant pulse.

A super-gaussian shape can be used to model the effects of steep leading and trailing edges on dispersion induced broadening.



gaussian shape



super-gaussian shapes

steep edges (steep leading and trailing edges)

For a super-gaussian pulse, we generalize

$$F(0,t) = \exp\left[-\frac{1+iC}{2}\cdot\left(\frac{t}{t_0}\right)^{2m}\right] \quad (23)$$

where The parameter $\underline{m}$ controls the degree of edge sharpness.

For $m=1$ we recover The chirped gaussian pulses.

For larger m, The pulse becomes <u>square shaped</u>

with sharper leading and trailing edges.
We study this case numerically $\hookrightarrow$.

The differences between gaussian and super-gaussian pulses can be attributed to the steeper leading and trailing edges associated with a super-gaussian puse.
Whereas the gaussian pulse maintains its shape during propagation, the supergaussian

pulse not only broadens at a faster rate but also distorts in shape.

Enhanced broadening of a supergaussian pulse can be understood by noting that its spectrum is wider than that of a Gaussian pulse because of steeper edges.