Tutorial on streak camera and coherence

The aim of this exercice is to make a link between coherence of a source, broadening mechanisms and spectral linewidth. This comes from purely classical consideration, and has broad physical consequences.

1 Homogeneous broadening

Think of individual atoms playing the role of light emitters. They emit photons at frequency ω_0, and experience homogeneous broadening. We want to study the temporal coherence and lineshape of this source.

— What physical mechanisms can lead to homogeneous broadening ?

— What is the expression of the first order coherence function ? How is it simplified in the case of homogeneous broadening.

— We assume a Poissonian distribution of time for the atomic collisions, meaning there the phase is stable for a time τ_c on average.

$$p(\tau)d\tau = \frac{1}{\tau_0}e^{-\tau/\tau_c}d\tau$$

Calculate the first order coherence function in this case.

— Using the Wiener-Khintchine theorem, calculate the spectral lineshape of this source.

2 Inhomogeneous broadening

— What physical mechanisms can lead to inhomogeneous broadening ? In the following, we should consider Doppler effect.

— Using the relation between frequency and velocity for the doppler effect, give the lineshape of the source.

— Based on this result, what is the form of the first order coherence function ?