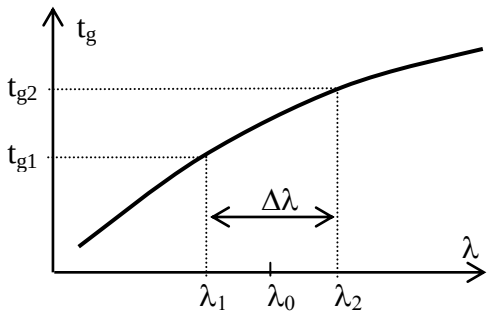
Exercice 4 : **Chromatic dispersion in a step index fiber**

Let us remind that the group index at the wavelength λ_0, in a medium having a refractive index n(λ), can be written : $N_g(\lambda_0) = n - \lambda_0 \left.\frac{dn}{d\lambda}\right|_{\lambda=\lambda_0}$.

1) a- What is the relation between $N_g(\lambda_0)$ and $t_g(\lambda_0)$, where $t_g(\lambda_0)$ is the propagation duration, in this medium of thickness L, of the peak of a light pulse which spectrum is narrow (width $\Delta\lambda$) and is centered at λ_0 ?
b- Using the schematics opposite, establish the expression of the time broadening $|\tau| = |t_{g1} - t_{g2}|$ experienced by the pulse when crossing the medium, as a function of t_g, λ and Δλ.



2) The dispersion of the material D_m being given by $D_m = \frac{\tau}{\Delta\lambda . L}$, show that $D_m = -\frac{\lambda}{c}\frac{d^2n}{d\lambda^2}$

In a single mode optical fiber, the refractive index of the core around the operating wavelength λ_T=0,85µm can be written $n_1(\lambda) = A_0 + A_1.e^{-\lambda K}$, with A_0 =1,45194, A_1= 0,0402 and K =1,63.10^6 m^{-1}.

3) Calculate D_m, the dispersion of the material in the core of the fiber at λ_T, in ps/(nm.km) and show that its value is D_m = -76 ps/(nm.km).

4) What should be the value of the guide dispersion around λ_T in order to obtain a temporal broadening of a pulse having a spectral width of 0,01nm around this wavelength of 200ps at the end of a 100km propagation length in the fiber (2 two possible values) ?

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