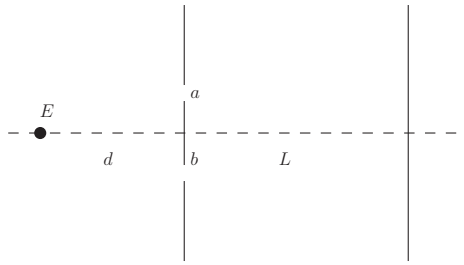
# Quantum Physics IV, Exercises 1

*Assistant : duccio.pappadopulo@epfl.ch; BSP 714*

## Exercise 1 : Double slit experiment

Discuss the double slit experiment. Assume the electrons are emitted from a thermionic lamp with a temperature $T$. Pay a particular attention to the role played by each scale :
$E$ : energy of the electrons,
$d$ : distance between the source and the double slit screen,
$L$ : distance between the double slit screen and the detector screen,
$a$ : width of the slits,
$b$ : distance between the slits.
What constraint to impose on the parameters in order to have at least one clear minimum?




## Exercise 2 : Gaussian integral 1

For all integrals, $\alpha > 0$.

- Compute the value of the real and imaginary gaussian integrals.

$$G_{\mathrm{Re}} = \int_{-\infty}^{+\infty} \mathrm{d}x\ e^{-\alpha x^2} \quad \text{and} \quad G_{\mathrm{Im}}^{\pm} = \int_{-\infty}^{+\infty} \mathrm{d}x\ e^{\pm i\alpha x^2}$$

- Compute, for all $n \in \mathbf{N}^+$, $\alpha > 0$

$$\int_{-\infty}^{\infty} x^n e^{-\alpha x^2} \tag{1}$$

- Estimate the error when computing the two integrals below :

$$G_{\mathrm{Re}}^{L} = \int_{-L}^{+L} \mathrm{d}x\ e^{-\alpha x^2} \quad \text{and} \quad G_{\mathrm{Im}}^{L} = \int_{-L}^{+L} \mathrm{d}x\ e^{+i\alpha x^2}$$

## Exercise 3 : Gaussian integral 2

$A$ is a $n$-dimensional symmetric positive definite matrix. Compute the $n$ dimensional Gaussian integral with and without current :

$$G_A(0) = \int_{-\infty}^{+\infty} \mathrm{d}^n x\ e^{iA_{ij}x_i x_j} \quad \text{and} \quad G_A(J) = \int_{-\infty}^{+\infty} \mathrm{d}^n x\ e^{iA_{ij}x_i x_j + iJ_i x_i}$$