Michelson-Interferometer

a) $E_1 = E_0\, \mathrm{e}^{i(kx-\omega t)}; \quad E_2 = E_0\, \mathrm{e}^{i(kx-\omega t+k\Delta s)}; \quad I = E^2$

$$I = E^2 = (E_1 + E_2)^2 = E_0^2\, \mathrm{e}^{2i(kx-\omega t)} \left(1 + \mathrm{e}^{i\Delta sk}\right)^2$$

$$I = \underline{\underline{E_0^2 \left(1 + 2\cos(\Delta sk) + \cos(\Delta sk)^2 - \sin(\Delta sk)^2\right)}}$$

b) The Energy goes back into the source because the two beams reflected from the mirror get split again into a wave interfering destructively (going towards the detector) and one interfering constructively traveling back towards the source.

Bestimmung des Wirkungsquerschnitts

a) A cathode releases electrons, which pass through a hole in a membrane into a chamber full of nitrogen. At the end the electrons hit a detector and from the current I_0 the electrons produce one can determine the cross-section of electrons and nitrogen.

b) Instead of only varying the thickness of the medium, one can also change the pressure. I imagine that varying the thickness requires the detector to be mobile which increases the length of the airtight enclosure for the nitrogen and generally adds complexity because you now need a contraption that accurately moves the detector.

$$I(p) = I_0\, \mathrm{e}^{-\beta p}$$

$$N(p) = N_0\, \mathrm{e}^{-\beta p} \qquad \text{,with } N_0 \propto I_0$$

$$pV = Nk_{\mathrm{B}}T \qquad \Rightarrow \qquad p = \frac{Nk_{\mathrm{b}}T}{V}$$

$$\Delta N = -WN = \frac{\frac{\Delta pV}{k_{\mathrm{B}}T}\sigma N}{A} = \frac{\Delta px\sigma N}{k_{\mathrm{B}}T}$$

$$\frac{\mathrm{d}N}{N} = \frac{\mathrm{d}px\sigma}{k_{\mathrm{B}}T}$$

$$N(p) = N_0\, \mathrm{e}^{-\frac{x\sigma}{k_{\mathrm{B}}T}p} \qquad \Rightarrow \qquad \beta := \underline{\underline{\frac{x\sigma}{k_{\mathrm{B}}T}}}$$

c) $x = 2.5\ \mathrm{m}; \quad T = 300\ \mathrm{K}$
$p_1 = 2 * 10^{-2}\ \mathrm{Pa}; \quad p_2 = 10^{-2}\ \mathrm{Pa}; \quad p_3 = 10^5\ \mathrm{Pa}; \quad p_4 = 7 * 10^4\ \mathrm{Pa}$

$$\mathrm{e}^{-\beta p_1} = 2\,\mathrm{e}^{-\beta p_2}$$
$$\sigma_1 = \frac{\ln(2) k_\mathrm{b} T}{(p_1 - p_2)x} = \underline{\underline{1.15 * 10^{-19}\ \mathrm{m}^2}}$$
$$\mathrm{e}^{-\beta p_3} = 2\,\mathrm{e}^{-\beta p_4}$$
$$\sigma_2 = \frac{\ln(2) k_\mathrm{b} T}{(p_3 - p_4)x} = \underline{\underline{3.83 * 10^{-26}\ \mathrm{m}^2}}$$

The Cross-section has drastically decreased because the more speed and momentum the electrons carry, the more they just smash through the gas and don't get scattered on the molecules

Geladene Teilchen in $\vec{E}$- und $\vec{B}$- Feldern

$$d = 0.105\ \mathrm{m}; \quad B = 1\ \mathrm{mT}; \quad U_\mathrm{b} = 220\ \mathrm{V}$$

a) $F_\mathrm{L} = qvB = \frac{mv}{r} \Rightarrow v = \frac{dqB}{m}; \quad E = Uq = \frac{mv^2}{2} \Rightarrow v^2 = \frac{2Uq}{m}$

$$\left(\frac{dqB}{m}\right)^2 = \frac{2Uq}{m}$$
$$\frac{q}{m} = \frac{2U}{d^2B^2} = \underline{\underline{3.99 * 10^{10}\ \mathrm{C/kg}}}$$

b) $v = \sqrt{\frac{2Uq}{m}}$

$$F_\mathrm{L} = q(E + vB) = 0$$
$$E = -vB = \sqrt{\frac{2Uq}{m}}B$$
$$\frac{q}{m} = \underline{\underline{\frac{E^2}{UB^2}}}$$