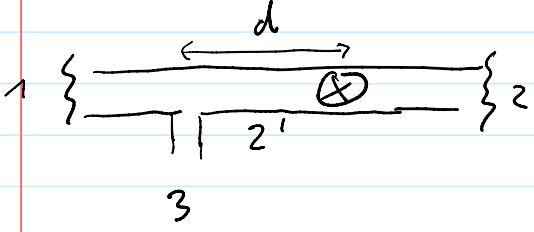
Nanofizika - Vaje

četrtek, 19. marec 2020 10:13

# Meritev napetosti v kv. vodniku s sipalcem




$$S^x = \begin{pmatrix} r & t' \\ t & r' \end{pmatrix}$$

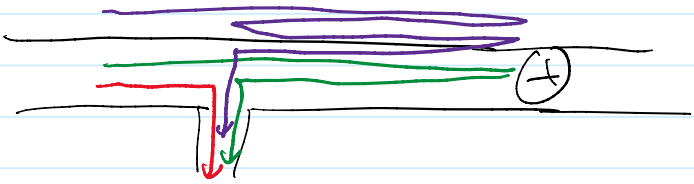
$$S^T = \begin{bmatrix} a & b & \sqrt{\varepsilon} \\ b & a & \sqrt{\varepsilon} \\ \sqrt{\varepsilon} & \sqrt{\varepsilon} & c \end{bmatrix}; \quad c = \sqrt{1-2\varepsilon} \simeq 1-\varepsilon$$

$$a = \frac{1-c}{2} \simeq \varepsilon/2$$

$$b = \frac{-(1+c)}{2} \simeq -1 + \varepsilon/2$$

$$I_2 = G_{23}\, U_3 \qquad G_{23} = G_0 \left(-S_{23} + |S_{23}|^2\right)$$

$$U_3 = \frac{T_{31}\, U_1 + T_{32}\, U_2}{T_{31} + T_{32}}$$

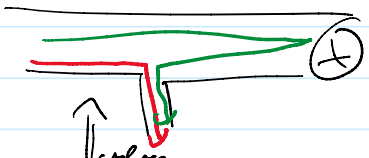


$$T_{31} = |S_{31}|^2$$

$$S_{31} = \sqrt{\varepsilon} + b\, e^{ikd}\, r\, e^{ikd}\sqrt{\varepsilon} + b\, e^{ikd}\, r\, e^{ikd}\left[a\, e^{ikd}\, r\, e^{ikd}\right]\sqrt{\varepsilon} + \left[\quad\right]^2 + \dots$$

$$S_{31} = \sqrt{\varepsilon} + t\,r\,e^{2ikd}\sqrt{\varepsilon}\,\frac{1}{1 - r\,a\,e^{2ikd}}$$

$$a \approx \varepsilon/2$$



$$S_{31} \approx \sqrt{\varepsilon}\,\left(1 + t\,r\,e^{2ikd}\right)$$

$$= \sqrt{\varepsilon}\,\left(1 - r\,e^{2ikd}\right)$$

člen reda $\sqrt{\varepsilon}$ (ostali višjega)

$$T_{31} = |S_{31}|^2 = \varepsilon\left(1 + |r|^2 - r\,e^{2ikd} - r^*\,e^{-2ikd}\right)$$

$$r = i\sqrt{1-T} \qquad |r|^2 = 1 - T$$

$$T_{31} = \varepsilon\left(1 + 1 - T - i\sqrt{1-T}\,\left(e^{2ikd} - e^{-2ikd}\right)\right)$$

$$T_{31} = \varepsilon\left(2 - T + 2\sqrt{1-T}\,\sin 2kd\right)$$

$$T_{32} = \varepsilon T \qquad \left(S_{32} = t\,e^{ikd}\sqrt{\varepsilon} + \text{členi višjega reda v } \varepsilon\right)$$

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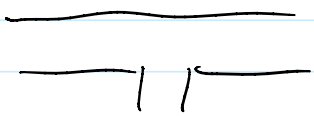
$$U_3 = \frac{T_{31}\,U_1 + T_{32}\,U_2}{T_{31} + T_{32}} = \frac{\varepsilon\left(\left(2 - T + 2\sqrt{1-T}\,\sin(2kd)\right)U_1 + T\,U_2\right)}{\varepsilon\left(2 - T + 2\sqrt{1-T}\,\sin(2kd) + T\right)}$$

oscilacije $U_3$ z $d$ zaradi interference!

Kaj pa če interferenčnih efektov ni?
(npr. zaradi končne temp., $G_{a3} = \int -f'(E)\,|S_{a3}|^2(E)\,dE$
ki povpreči po fazah, saj $k = k(E)$)

$$U_3 = \frac{(2 - T)\,U_1 + T\,U_2}{2}$$

To bi lahko izpeljali tudi z verjetnostmi



$$T_{31} = \varepsilon + 1 \cdot |r|^2 \varepsilon = \varepsilon(2-T)$$
$$T_{32} = \varepsilon T$$

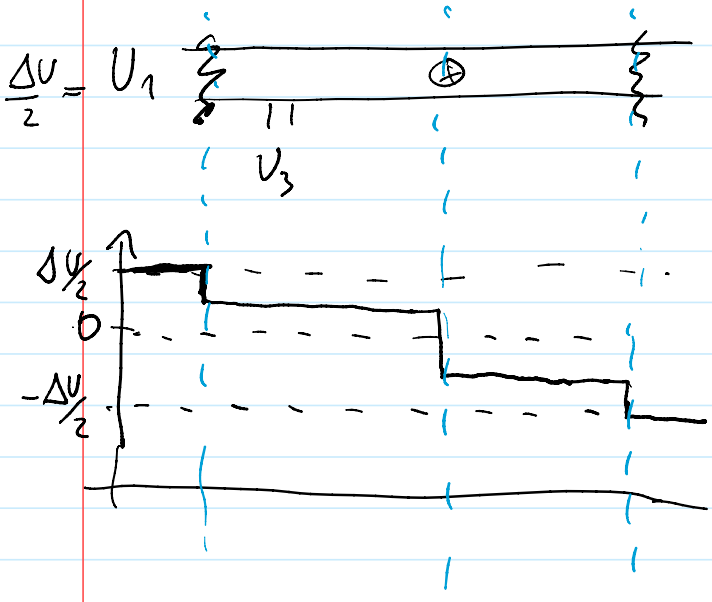
(+ procesi višjega reda v $\varepsilon$)

Poglejmo, kaj rezultat za $U_3$ pomeni.

Izberimo $U_1 = +\Delta U/2$ $\quad U_1 = -\Delta U/2$

$$U_3 = (1-T)\frac{\Delta U}{2}$$

[desna od zapalca $U_3' = -(1-T)\frac{\Delta U}{2}$]




| kraj | padec napetosti | tok | upornost |
|---|---|---|---|
| levi kont. | $T\Delta U/2$ | $\Delta U T G_0$ | $\frac{1}{2G_0} = \frac{h}{4e^2}$ |
| zapalec | $(1-T)\Delta U$ | $\Delta U T G_0$ | $\frac{1-T}{TG_0}$ |
| desni kont | $T\Delta U/2$ | $\Delta U T G_0$ | $\frac{1}{2G_0} = \frac{h}{4e^2}$ |

Uporaba kontaktov.
tudi če zapalca ni ($T \to 1$)
padec napetosti, ker

tudi če signalca ni ($T \to 1$)
padeck nujno tasti, ker
kvantni kanal v optiki z
obema rezervacijama.