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Exercise 3

DTLa
Friday 5th March, 2021

1 Diffusion in Photodiodes

a)

$$L_n = (D\tau)^{1/2} \tag{1}$$

$$D = \frac{kT\mu}{q} \tag{2}$$

The diffusion length must be much larger than the thickness of the neutral absorbiton layer. If this is not the case charge carriers will be reabsorbed without leading to an electric signal.

$$\begin{gathered} L_n >> l \\ (D\tau)^{1/2} >> l \end{gathered} \tag{3}$$

Since $\tau \propto N_i^{-1}$:

$$l << \sqrt{D N_i^{-1}} \tag{4}$$

b) Find η for $l = L_n$, $l = 10L_n$ and $l = 1/10L_n$:

- $l = L_n$: $\eta_{L_n} = \frac{2b}{e^1 + e^{-1}} \approx 0.32 \times 2b$
- $l = 10L_n$: $\eta_{10L_n} = \frac{2b}{e^{10} + e^{-10}} \approx 0.000045 \times 2b$
- $l = 1/10L_n$: $\eta_{1/10L_n} = \frac{2b}{e^{0.1} + e^{-0.1}} \approx 0.49 \times 2b$

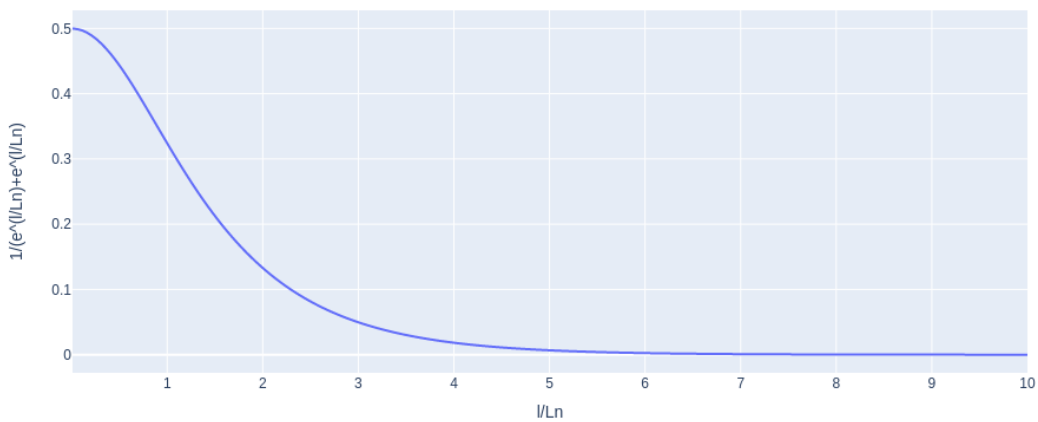

Figure 1: Plot of $\frac{1}{e^{0.1} + e^{-0.1}}$.

The quantum efficiency indeed increases as l/L_n decreases. Considering only this a very small would be desirable. Another solution (see Equation 4) would be to have a very low N_i.

c) For good photon absorbance the extrinsic detectors need to be heavily doped, i.e. N_i needs to be large. It is not possible to have very good characteristics for both aspects from b) and c). However, N_i can be optimized and other methods can be employed to have high-performant extrinsic

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2 Image noise processing

Please see the print-outs and files for the results of the questions. The code and files are also on GitLab and can be cloned via the SSH: git@gitlab.com:lukas_welzel/dtla.git.

2 a)

C1	10.010
C2	14.531
C3	16.993
C4	12.310

Table 1: Q2 a) channel offsets.

2 b) x=35, y=85
See Hist. Equ. & Gauss. Filt. plot. The Hist. Equ. enhances global contrast & the gaussian filter filters out what might be hot pixels/ less luminous objects.

3 x=195, y=375
See Hist. Equ. & Gauss. Filt. plot. The Hist. Equ. enhances global contrast & the gaussian filter filters out what might be hot pixels/ less luminous objects.

4 a) the two dominant structures we see are: Hot or rouge pixels (cant really decide without seeing if they can be fixed) and (if we histogram equalize the images) we can also see the thermal straylight.

4 d) the approximate position of the brown dwarf is x=34px, y=75px (my processed image) or x=64px, y=75px (raw image b).