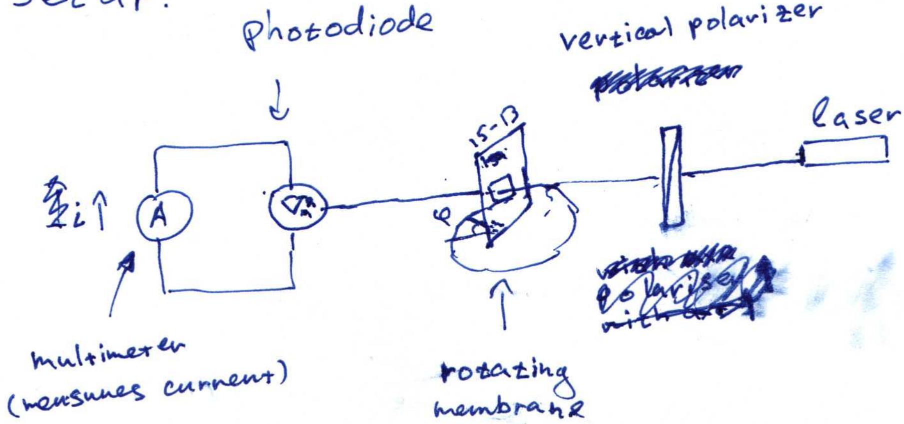
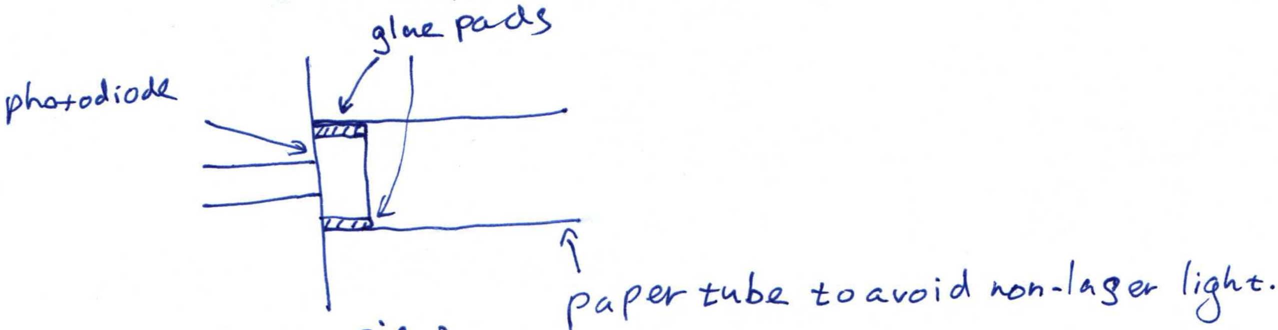
B. Interference.

Setup:

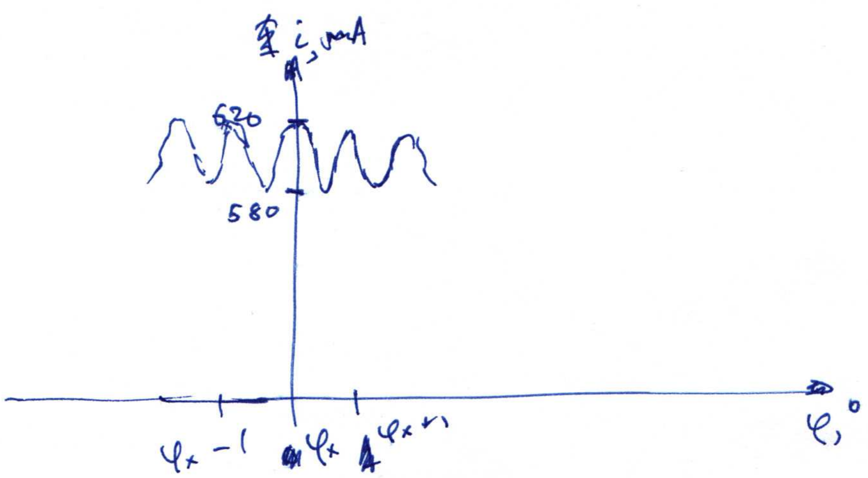


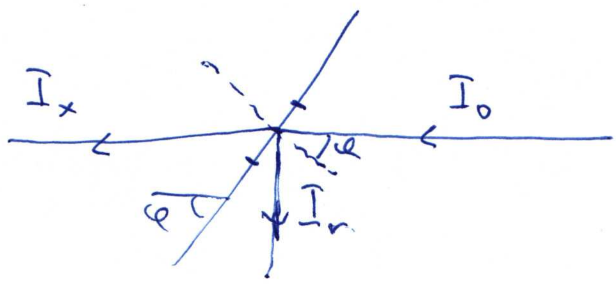
pic. 1



pic. 2

I rotated ~~the~~ membrane very slow, so I could see, how current ~~I~~ i changes.
Approximate dependency $i(\varphi)$. (φ from pic. 1):



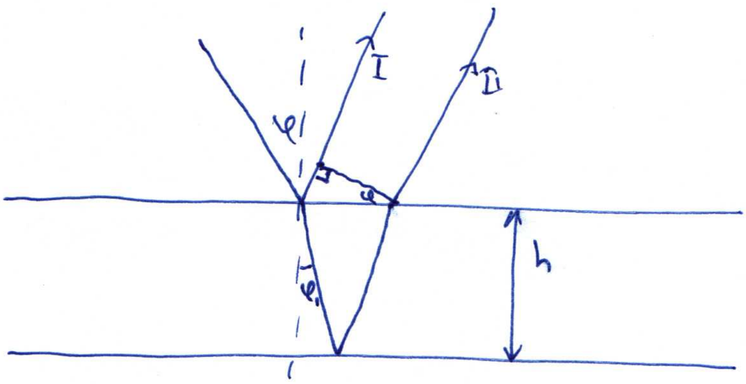


membrane

I_r - reflected light (intensity)

$I_x = I_0 - I_r$; $I_0 = const$

Let us look at I_r:



Difference of optical length between beams I and II is

$\Delta = n_0 \cdot 2(\cos(\varphi_1))^{-1} \cdot h - 2h\sin(\varphi_1) \cdot \sin\varphi$. ~~for small φ~~

~~for small φ:~~

$\cancel{\varphi_1 = \frac{\varphi}{n_0} ; \Delta = 2nh \frac{1}{\cos\varphi_1} - 2h\sin\varphi\sin\varphi_1 =}$ $\sin\varphi_1 = \frac{\sin\varphi}{n_0}$

$\Delta = 2h\left(\frac{n_0}{\cos\varphi_1} - \frac{\sin^2\varphi}{n_0}\right)$

let us count amount of „spikes" in range $\hat{\varphi}_0 \le \varphi \le \hat{\varphi}_1$ n_Δ

$$\lambda n_\Delta = \left|\left(\Delta(\varphi)\Big|_{\hat{\varphi}_0}^{\hat{\varphi}_1}\right)\right| = h\left|\left(\left(2\frac{n_0}{\cos(\varphi_1(\varphi))} - \frac{\sin^2\varphi}{n_0}\right)\Big|_{\hat{\varphi}_0}^{\hat{\varphi}_1}\right)\right|$$

$$\Downarrow$$

$$h = \frac{\lambda n_\Delta}{2\left|\left(\left(\frac{n_0}{\cos(\varphi_1(\varphi))} - \frac{\sin^2\varphi}{n_0}\right)\Big|_{\varphi_0}^{\hat{\varphi}_1}\right)\right|}$$

measurements:

n_Δ	$\hat{\varphi}_0$, °	$\hat{\varphi}_1$, °	h, мкм
12	40	49	137
20	20	37	99
14	40	50	148
36	20	50	109

1.3535

~~$\langle h \rangle = 123$ мкм~~

$\langle h \rangle = 123$ мкм

~~Let us get~~ We'll get dependency n from Δn

$$\sin\beta_2 = \frac{n_2}{n_0}\sin\beta$$

$$\frac{1}{n_2^2} = \frac{\cos^2\beta_2}{n_0^2} + \frac{\sin^2\beta_2}{(n_0+\Delta n)^2} = \frac{\cos^2\beta_2 (n_0+\Delta n)^2 + \sin^2\beta_2 n_0^2}{n_0^2 (n_0+\Delta n)^2} =$$

$$= \frac{n_0^2 + 2 n_0 \Delta n \cos^2\beta_2}{n_0^2 (n_0+\Delta n)^2} = \frac{n_0^2\left(1 + \frac{2\Delta n \cos^2\beta_2}{n_0}\right)}{n_0^2 (n_0+\Delta n)^2}$$

$$n_2^2 = (n_0+\Delta n)^2 \left(1 - 2\frac{\Delta n}{n_0}\cos^2\beta_2\right) =$$

$$= n_0^2 - 2n_0\Delta n \cos^2\beta_2 + 2 n_0 \Delta n =$$

$$= n_0^2 + 2n_0\Delta n \sin^2\beta_2 = n_0^2\left(1 + 2\frac{\Delta n}{n_0}\sin^2\beta_2\right)$$

$$n_2 = n_0\left(1 + \frac{\Delta n}{n_0}\sin^2\beta_2\right) = n_0 + \Delta n \sin^2\beta_2 =$$

$$\sin\beta_2 = \sin\beta_1 + O(\Delta n)$$

$$= n_0 + \Delta n \underbrace{\frac{\sin^2\varphi}{n_0^2}}$$

Student's code (e.g. RUS 1)	Problem number (e.g. ☑)	Page number/Total (e.g. 5/8)
RUS 2	Experiment	8 /9

~~cosβ2~~

$$\cos\beta_2 - \cos\beta_1 = \sin\beta_1(\beta_1 - \beta_2) = \sin\beta_1 \cdot \frac{\sin(\beta_1) - \sin(\beta_2)}{\cos(\beta_1)} =$$

$$= tg\,\beta_1 \cdot \sin\varphi\left(\frac{1}{n_0} - \frac{1}{n_0 + \Delta n \frac{\sin^2\varphi}{n_0^2}}\right) =$$

$$= tg\,\beta_1 \sin\varphi \cdot \left(\Delta n \frac{\sin^2\varphi}{n_0^4}\right) = \frac{\sin^2\varphi}{n_0\cos\beta_1}\Delta n\frac{\sin^2\varphi}{n_0^4} =$$

$$= \frac{\sin^4\varphi}{n_0^5}\frac{\Delta n}{\cos\beta_1}$$

$$\delta = h\cos\beta_1(n_1 - n_2) + h n_0(\cos\beta_1 - \cos\beta_2) =$$

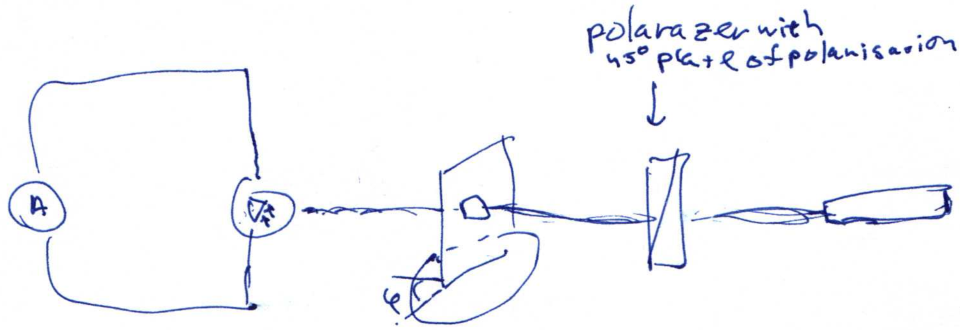
$$= \left(h\cos\beta_1\Delta n\frac{\sin^2\varphi}{n_0^2} + h n_0\frac{\sin^4\varphi}{n_0^5}\Delta n/\cos\beta_1\right) =$$

$$= -h\left(\cos\beta_1\frac{\sin^2\varphi}{n_0^2} + \frac{\sin^4\varphi}{n_0^4}/\cos\beta_1\right)\Delta n \qquad \sin\beta_1 = \frac{\sin\varphi}{n_0}$$

~~Same as in part B~~

n_0	φ_0	φ_1
~~1.2~~	~~40~~	~~50~~

Setup:



first maximum (not main) at

$\varphi_m = 35^{\circ}$

$\sin\beta_1 = \frac{\sin\varphi}{n_0}$

$$\Delta n = \frac{\lambda}{h\left(\cos\beta_1 \frac{\sin^2\varphi}{n_0^2} + \frac{\sin^4\varphi}{n_0^4\cos\beta_1}\right)\Big|_0^{\varphi_m}} =$$

$= 0.034$

$p = 0.12$

D:

$$p = n_S \underset{(\text{part A})}{} \cdot \pi \frac{d^2}{4}$$