

Soap Film

Problem:

Explain the appearance and the development of colours in a soap film, arranged in different geometrical ways.

- Theory

- * Interference At Thin Layers
- * Development Of Soap Films

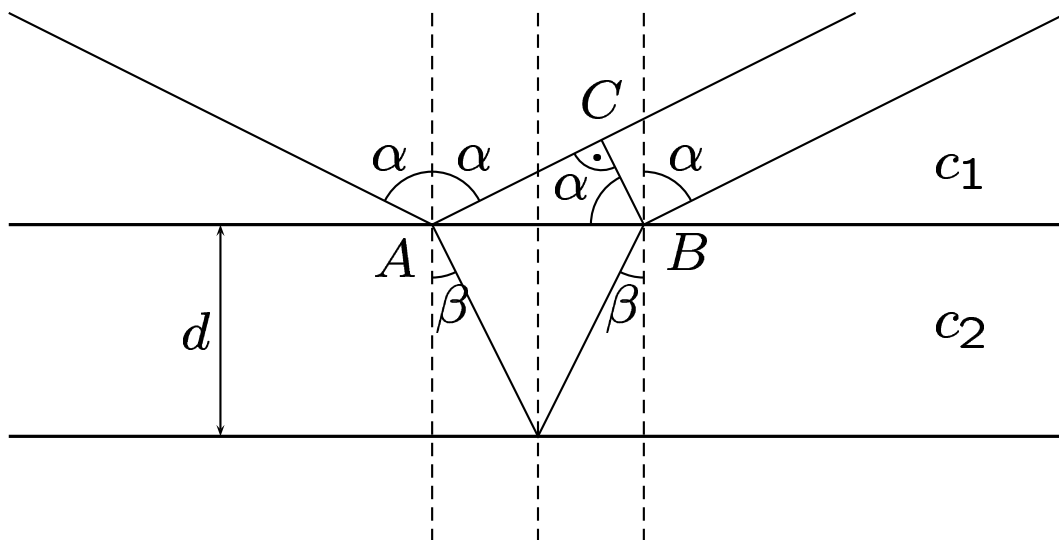
- Experiment
- Conclusions

- * Thickness Of Soap Films
- * Motion Of The Colours

Theory

Interference At Thin Layers

- reflection of incoming light at top and bottom of membran



- interference of the two coherent beams
- coherence because of same light source

- discription of colours in reflected light

- geometrical phase difference

$$\Delta s = 2dn\sqrt{1 - \frac{\sin^2\alpha}{n^2}}$$

- optical phase difference

$$\Delta s = 2dn\sqrt{1 - \frac{\sin^2\alpha}{n^2}} + \frac{\lambda}{2}$$

Theory

Interference At Thin Layers

- maxima at $\Delta s = k\lambda$
- minima at $\Delta s = (2k - 1)\frac{\lambda}{2}$
- amplification and moderation of colours
- colours are no colours of the spektrum
- always amplifications of more than one colour
- if $\Delta s < \frac{\lambda}{4}$ film is black
- if Δs gets to large colours are blurred

Theory

Development Of Soap Films

- surface tension $\sigma = \frac{dW}{dA}$
- always lowest energy in any surface
- without gravity minimal surfaces
- on special geometries minimal surfaces, too
- liquid flows along surface
- different diameters depending on time

Soap Film

Phase Difference

names as seen in the sketch

$$t = \frac{s}{c} \quad (1)$$

$$\frac{s_1}{c_1} = \frac{s_2}{c_2} \quad (2)$$

$$\frac{\Delta s + \overline{AC}}{c_1} = \frac{\overline{AD} + \overline{DB}}{c_2} \quad (3)$$

$$\Delta s = n(\overline{AD} + \overline{DB}) - \overline{AC} \quad (4)$$

$$\frac{d}{\overline{AD}} = \cos\beta \quad (5)$$

$$\frac{\overline{AC}}{\overline{AB}} = \sin\alpha \quad (6)$$

$$\frac{\overline{AB}}{\overline{AB}} = 2d \tan\beta \quad (7)$$

$$\Delta s = n \left(\frac{2d}{\cos\beta} \right) - 2d \tan\beta \sin\alpha \quad (8)$$

$$\Delta s = 2d \frac{n - \sin\beta \sin\alpha}{\cos\beta} \quad (9)$$

Soap Film

$$n = \frac{\sin\alpha}{\sin\beta} \quad (10)$$

$$\Delta s = 2d \frac{n - \frac{\sin^2\alpha}{n}}{\sqrt{1 - \sin^2\beta}} \quad (11)$$

$$\Delta s = 2d \frac{n - \frac{\sin^2\alpha}{n}}{\sqrt{1 - \frac{\sin^2\alpha}{n^2}}} \quad (12)$$

$$\Delta s = 2dn \sqrt{1 - \frac{\sin^2\alpha}{n^2}} \quad (13)$$

- only one reflection at border from media with larger n to media with lower n
→ additional phase difference of $\frac{\lambda}{2}$

$$\Delta s = 2dn \sqrt{1 - \frac{\sin^2\alpha}{n^2}} + \frac{\lambda}{2} \quad (14)$$