Soap Film

Problem:
Explain the appearance and the development of colours in a soap film, arranged in differentgeometrical ways.

- Theory

  * Interference At Thin Layers
  * Development Of Soap Films

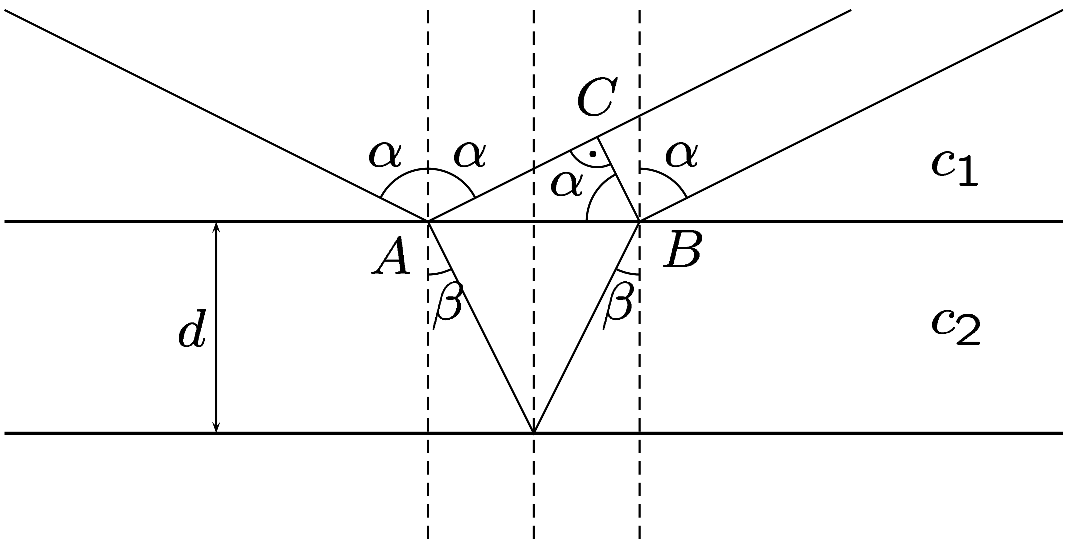
- Experiment
- Conclusions

  * Thickness Of Soap Films
  * Motion Of The Colours

Theory

Interference At Thin Layers

- reflection of incomming 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
- liqiud flows along surface
- different diameters depending on time

Phase Difference

names as seen in the sketch

$$t = \frac{s}{c} \tag{1}$$

$$\frac{s_1}{c_1} = \frac{s_2}{c_2} \tag{2}$$

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

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

$$\frac{d}{\overline{AD}} = cos\beta \tag{5}$$

$$\frac{\overline{AC}}{\overline{AB}} = sin\alpha \tag{6}$$

$$\overline{AB} = 2dtan\beta \tag{7}$$

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

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

$$n = \frac{sin\alpha}{sin\beta} \tag{10}$$

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

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

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

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

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