

The background features abstract, wavy shapes in shades of purple and pink, primarily located in the corners of the frame. The central text is set against a plain light gray background.

Goos-Hänchen shift

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Summary

01 Introduction

02 Goss-Hänchen shift for a plane surface

03 Measuring the Goos-Hänchen shift

04 Conclusion



01 Introduction

The discovery

1730: Newton

1947: Fritz Goos and
Hilda Hänchen

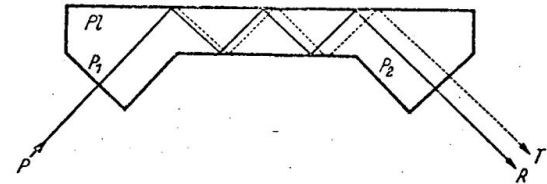
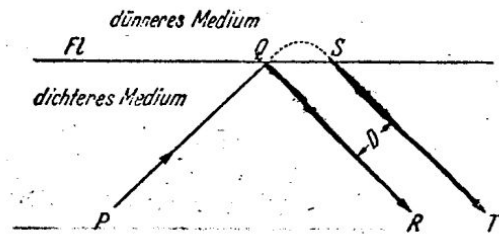


Fig. 4 : Principle of multiple reflection

And what came next...

1948: Artmann and von Fragstein

1960: Brekhoviskihk

1964: Renard

1970: Lotsch

1972: Chiu and Quinn

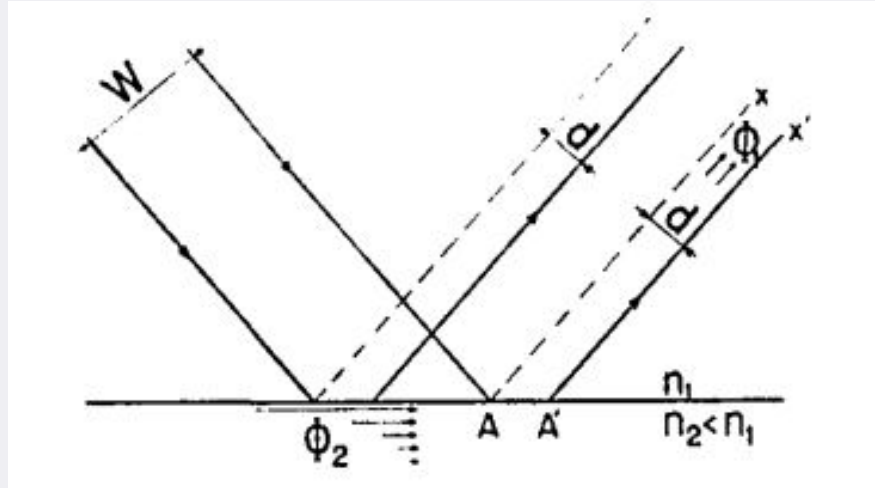
1972: Imbert-Fedorov

1977: McGuirk and Carniglia



02 Goos-Hänchen shift for a plane surface

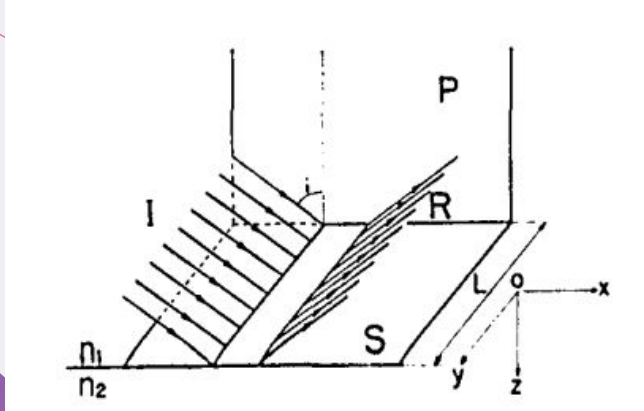
Goos-Hänchen shift for a plane surface



Case A: Electric vector perpendicular to the plane of incidence (TE)

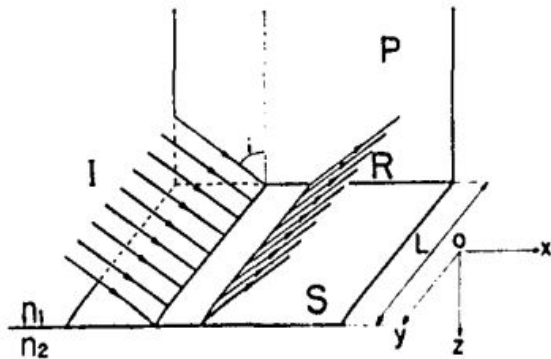
$$M_2^2 = \frac{64\pi^2 D_1^2}{K_1 \mu_1} \cdot \frac{\cos^2 \theta_i (2 \sin^2 \theta_1 - K\mu)}{\mu^2 \cos^2 \theta_i + \sin^2 \theta_i - K\mu}$$

$$M_1 = \frac{4\pi}{\sqrt{K_1 \mu_1}} D_1$$



Case A: Electric vector perpendicular to the plane of incidence (TE)

$$\Phi_2 = \frac{L}{32\pi^2} \left(\frac{\mu_2}{K_2} \right)^{1/2} \frac{1-\gamma_2^2}{1+\gamma_2^2} \frac{\lambda_2}{\gamma_2} M_2^2$$



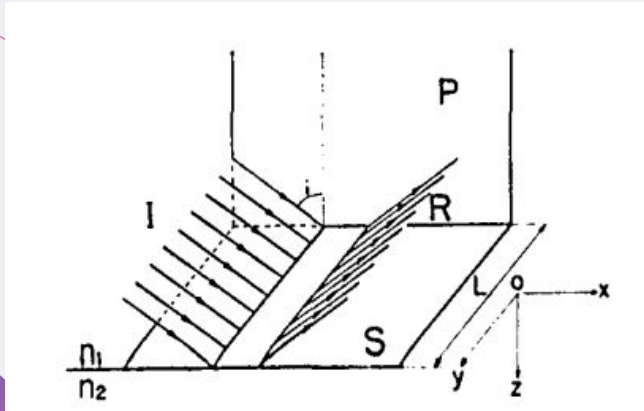
$$\gamma_2^2 = 1 - n^2 / \sin^2 \theta_i$$

$$n^2 = n_2^2 / n_1^2 = K_2 \mu_2 / K_1 \mu_1 = K \mu$$

$$\lambda_2 = \lambda_{vacuum} / n_2$$

Case A: Electric vector perpendicular to the plane of incidence (TE)

$$\Phi_1 = \frac{L d_{TE}}{8\pi} \left(\frac{\mu_1}{K_1} \right)^{1/2} M_1^2$$



By energy conservation:

$$\Phi_1 = \Phi_2$$

Case A: Electric vector perpendicular to the plane of incidence (TE)

$$d_{TE} = \frac{1}{\pi} \frac{\mu \sin \theta_i \cos^2 \theta_i}{\mu^2 \cos^2 \theta_i + \sin^2 \theta_i - n^2} \frac{\lambda_1}{\sqrt{\sin^2 \theta_i - n^2}}$$

Case A: Electric vector perpendicular to the plane of incidence (TE)

$$d_{TE} = \frac{1}{\pi} \frac{\mu \sin \theta_i \cos^2 \theta_i}{\mu^2 \cos^2 \theta_i + \sin^2 \theta_i - n^2} \frac{\lambda_1}{\sqrt{\sin^2 \theta_i - n^2}}$$

For $\sin \theta_i \simeq n$

$$d_{TE} \simeq \frac{\sin \theta_i}{\pi} \frac{\lambda_1}{\sqrt{\sin^2 \theta_i - n^2}}$$

Artmann and von
Fragstein's equation

Case B: Electric vector parallel to the plane of incidence (TM)

$$d_{TM} = \frac{1}{\pi} \frac{K \sin \theta_i \cos^2 \theta_i}{K^2 \cos^2 \theta_i + \sin^2 \theta_i - n^2} \frac{\lambda_1}{\sqrt{\sin^2 \theta_i - n^2}}$$

Case B: Electric vector parallel to the plane of incidence (TM)

$$d_{TM} = \frac{1}{\pi} \frac{K \sin \theta_i \cos^2 \theta_i}{K^2 \cos^2 \theta_i + \sin^2 \theta_i - n^2} \frac{\lambda_1}{\sqrt{\sin^2 \theta_i - n^2}}$$

For $\sin \theta_i \simeq n$

$$d_{TM} \simeq \frac{\sin \theta_i}{\pi n^2} \frac{\lambda_1}{\sqrt{\sin^2 \theta_i - n^2}}$$

Artmann and von
Fragstein's equation

Renard's arguments

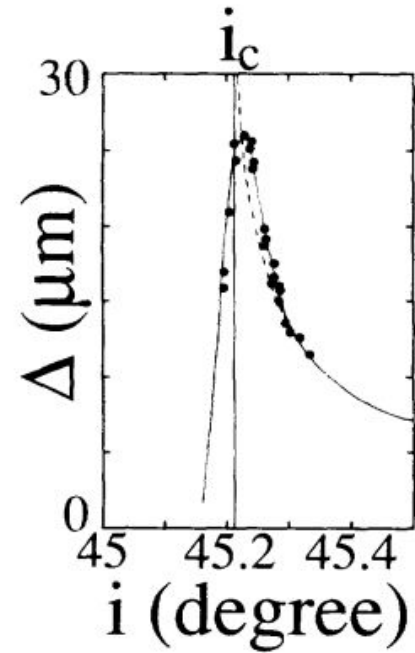
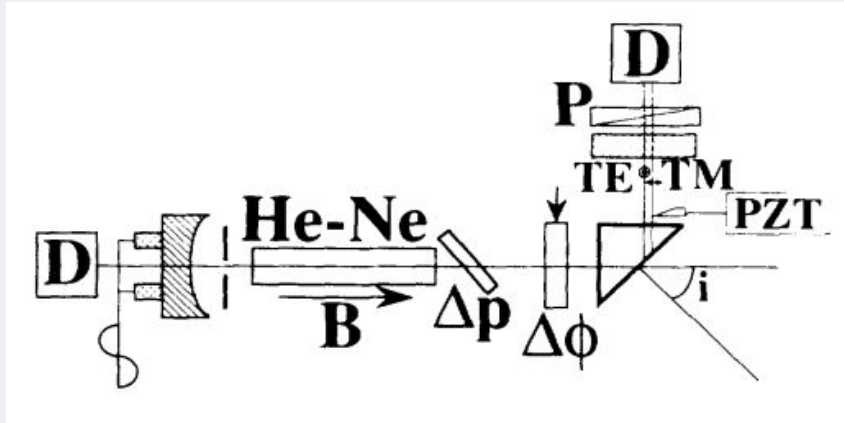
Artmann and von
Fragstein's equation

$$d_{TE} \simeq \frac{\sin \theta_i}{\pi} \frac{\lambda_1}{\sqrt{\sin^2 \theta_i - n^2}}$$
$$d_{TM} \simeq \frac{\sin \theta_i}{\pi n^2} \frac{\lambda_1}{\sqrt{\sin^2 \theta_i - n^2}}$$



03 Measuring the Goos-Hänchen shift

The Bretenaker method (1992)



There are so many ways....

1950: Goos and
Hänchen/Wolter method

1972: Imbert-Fedorov

1977: Cowan and Anicin
method

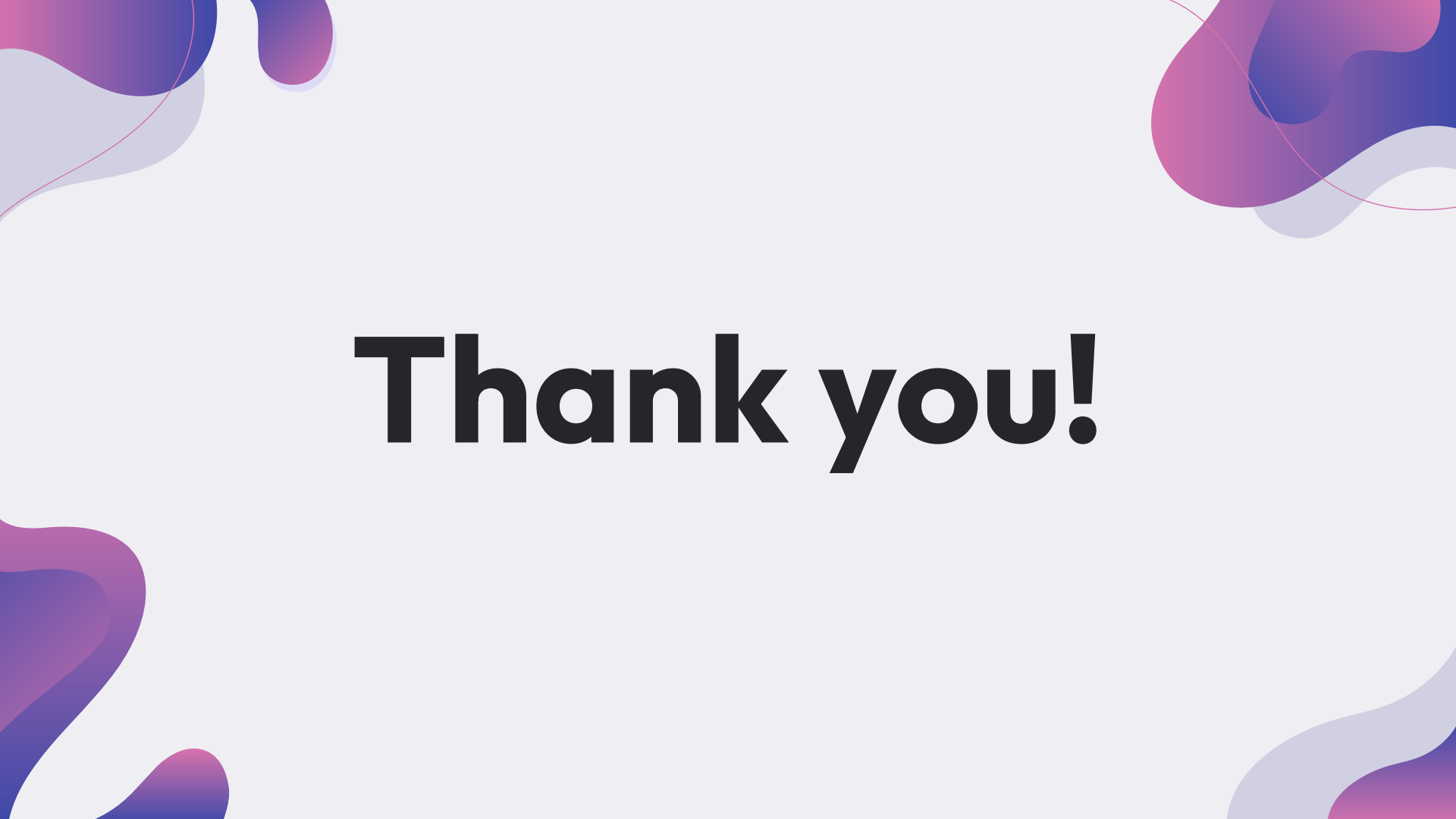
2008: Schwefel

The background features decorative wavy shapes in shades of purple and pink in the corners. The text is centered on a light gray background.

04 Conclusion

Nowadays....

- Nanophotonics and metasurfaces
- Sensitive detection of biological molecules
- Giant Goos-Hänchen shift

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Thank you!