Superposition of waves of different $|K|$

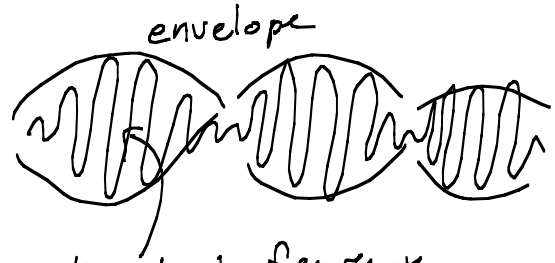
$\frac{\partial^2}{\partial z^2}\vec{E} = \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\vec{E}$ D'Alembert solution $E(z \pm ct)$

$c \rightarrow$ phase velocity $\frac{\omega}{K}$

$$\vec{E} = \cos\left[\left(K_0 - \frac{\Delta k}{2}\right)z - \left(\omega_0 - \frac{\Delta\omega}{2}\right)t\right] + \cos\left[\left(K_0 + \frac{\Delta k}{2}\right)z - \left(\omega_0 + \frac{\Delta\omega}{2}\right)t\right]$$

$$\cos(u-v) + \cos(u+v) = 2\sin u \sin v$$

$$= 2\sin(K_0 z - \omega_0 t)\sin(\Delta k z - \Delta\omega t)$$



$\frac{\omega_0}{K_0}$ "phase velocity" $\frac{\Delta\omega}{\Delta K}$ "group velocity" high frequency "carrier"

Continuum of waves: $E \rightarrow \int_{-\infty}^{\infty} A(k) e^{i(kz - \omega(k)t)}\, dk$

$\frac{\Delta\omega}{\Delta K} \rightarrow \frac{d\omega}{dK}$

for light in vacuum, $\omega(K) = cK$ "dispersion rel'n", $\frac{\omega(K)}{K} = c$ and $\frac{d\omega(K)}{dK} = c$

New Page 1 - Google Chrome

http://www.physics.byu.edu/faculty/durfee/Java/simulations/Dispersion.htm

Get Help!

Dr. Bongo's Dispersion Lab

RESET ALL

Dispersion Relation: ω(k)

0.01*k^(1.4)

Pulse Width (w)

0.1

Central Wavenumber (k)

75

Envelope: f(x,w)

exp(-(x/(w*2))^2)

x-Axis Velocity

0.0

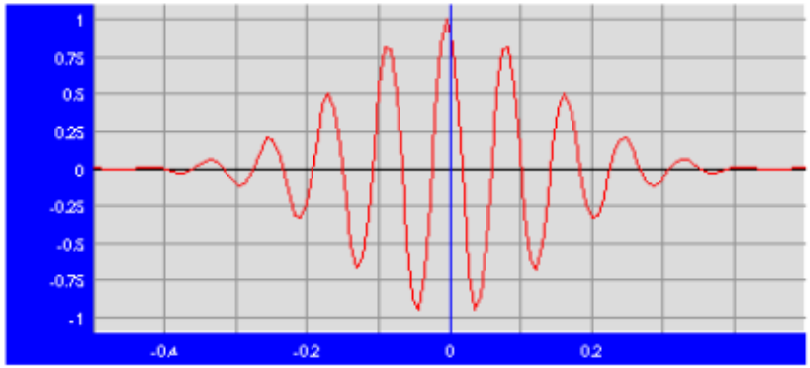
Time

0.0

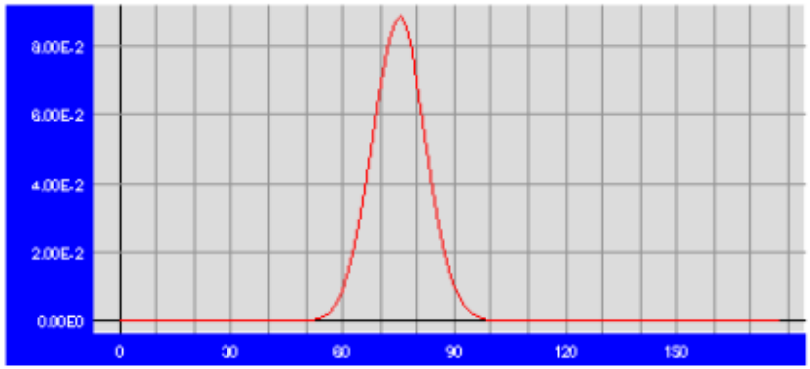
Go!

Reset t=0

The wave: f(x)



Its spectrum: A(k)



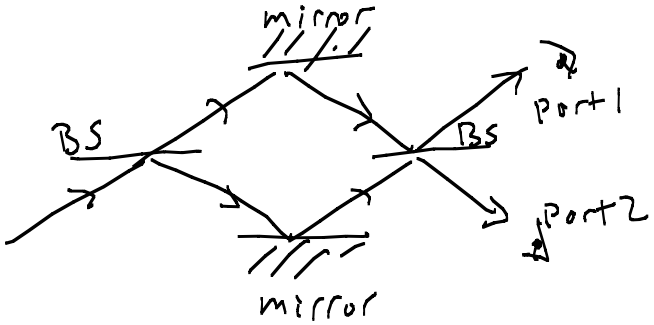
Δx = 0.1

Δk = 5.01

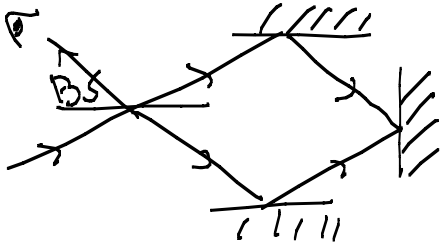
ΔxΔk = 0.5

The simulation has gone as far as it can reliably go. Reset time to 0 to continue.

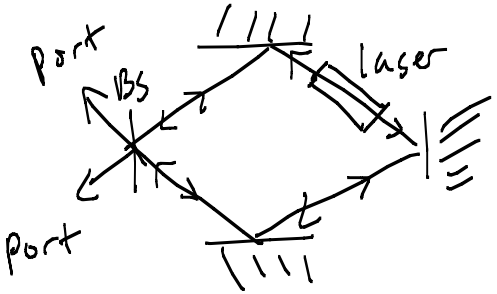
Other Interferometers:



"Mach - Zehnder"



"Sagnac"



"ring laser"

Applications

Tests of Relativity:

Special

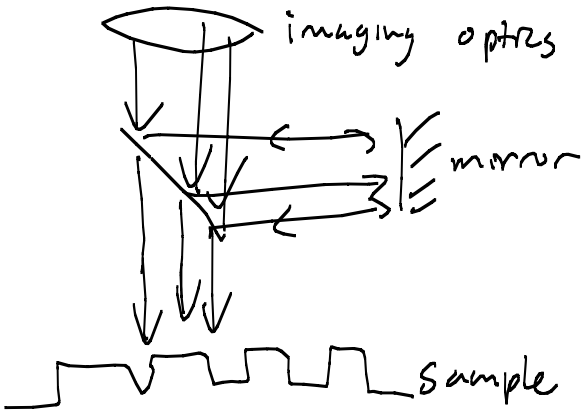
Michelson-Morley expt.

Fizeau

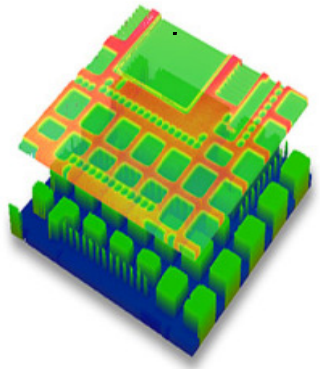
General

LIGO: 2 modified MM interferometers (LA + WA)
2.5 miles arm length.

Metrology:



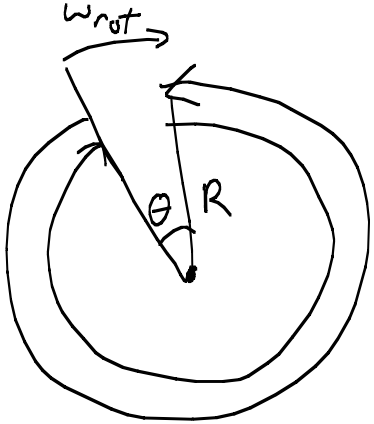
Imaging interferometer



Zygo.com

gyroscopes: inertial guidance

Sagnac interferometer:



$\pm$: cw
$\mp$: ccw

$$t = \frac{2\pi R}{c} \pm \frac{(\omega t)R}{c}$$

$$t\left(1 \mp \frac{\omega_{rot} R}{c}\right) = \frac{2\pi R}{c}$$

$$(1+\varepsilon)^n \sim 1 + n\varepsilon \quad \varepsilon << 1$$

$$t = \frac{2\pi R}{c}\left(1 \mp \frac{\omega_{rot} R}{c}\right)^{-1} \sim \frac{2\pi R}{c}\left(1 \pm \frac{\omega_{rot} R}{c}\right)$$

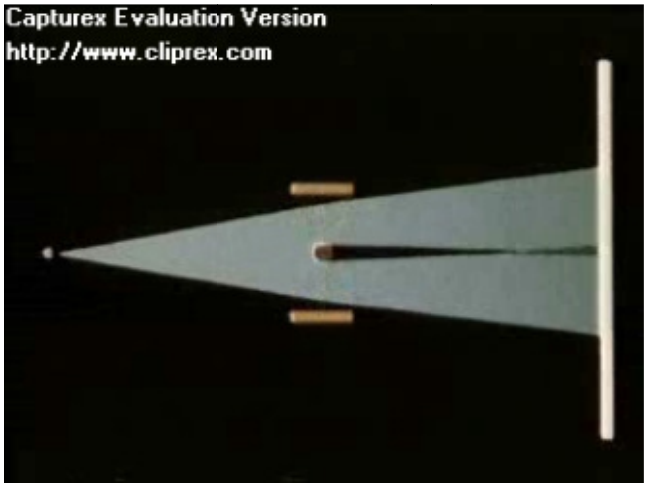
$$\Delta\phi = \omega \Delta t = 2\omega \frac{2\pi R}{c} \frac{\omega_{rot} R}{c} = \frac{4\pi R^2}{c^2} \omega \omega_{rot}$$

↑ Interference

Important for airplane/submarine/etc navigation

Electron Interferometry: Vacuum

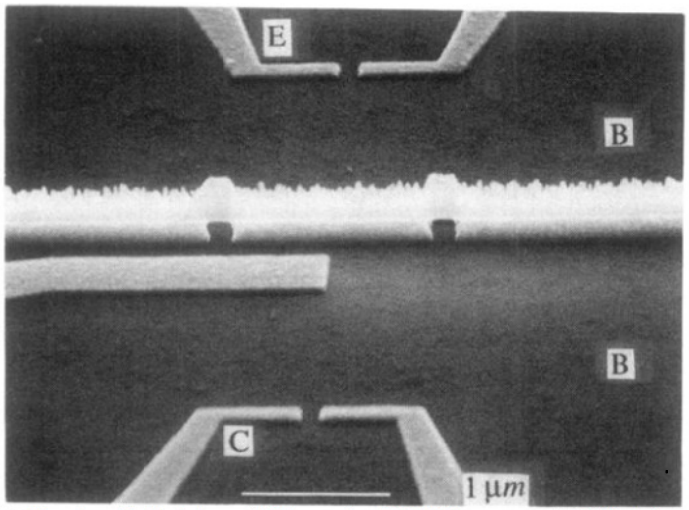
electrostatic biprism



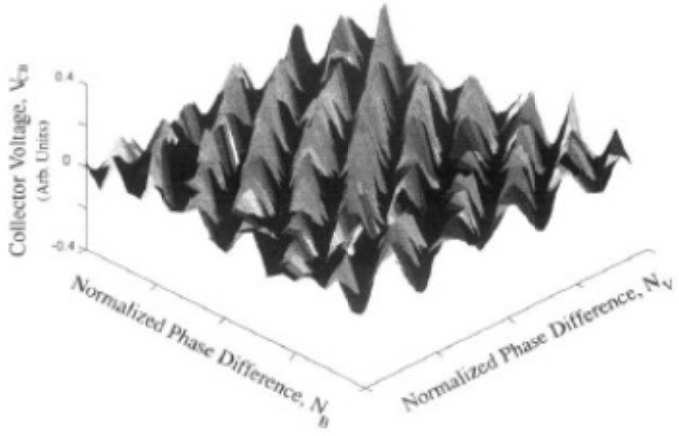
Like Young's 2-slit experiment

Electron Interferometry: Solid State

two-slit:



A. Yacoby, M. Heiblum, V. Umansky, H. Shtrikman, and D. Mahalu
- Phys. Rev. Lett. 73, 3149 (1994)



An electronic Mach–Zehnder interferometer

Yang Ji, Yunchul Chung, D. Sprinzak, M. Heiblum, D. Mahalu & Hadas Shtrikman

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