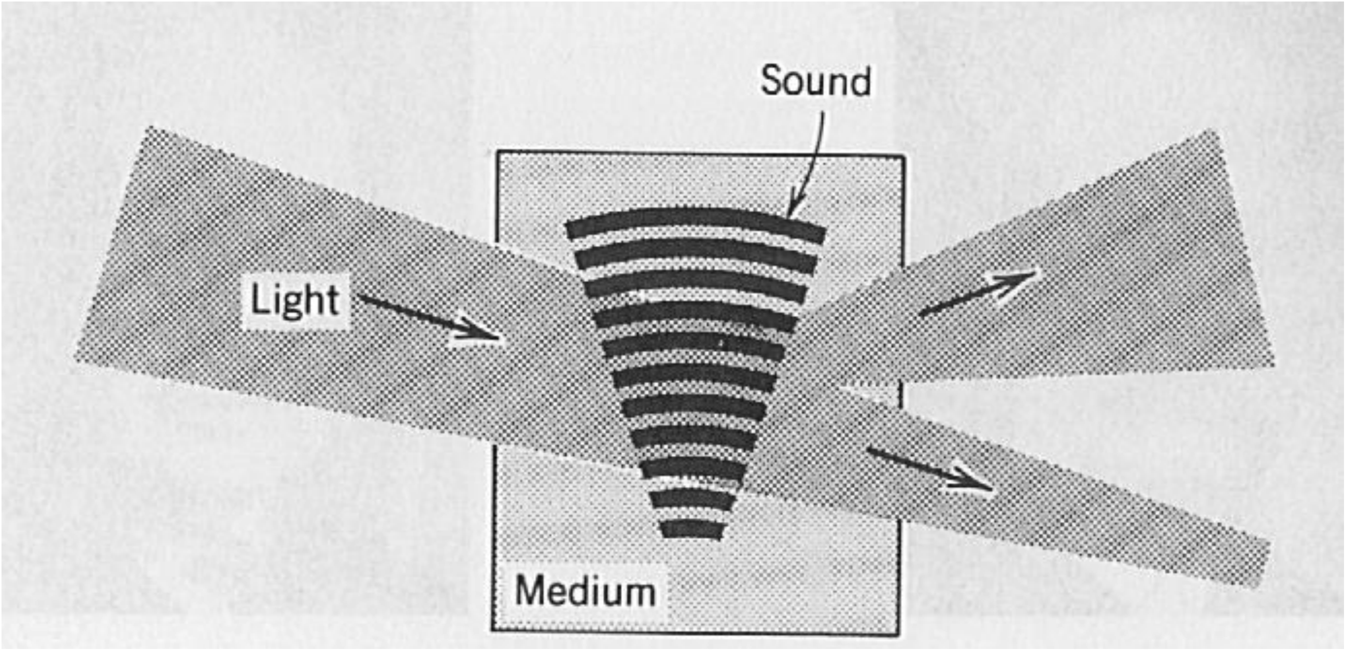
WORCESTER POLYTECHNIC INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT

Optical Metrology and NDT
ME-593L, B'2011

Introduction: Temporal Heterodyning
21 November 2011

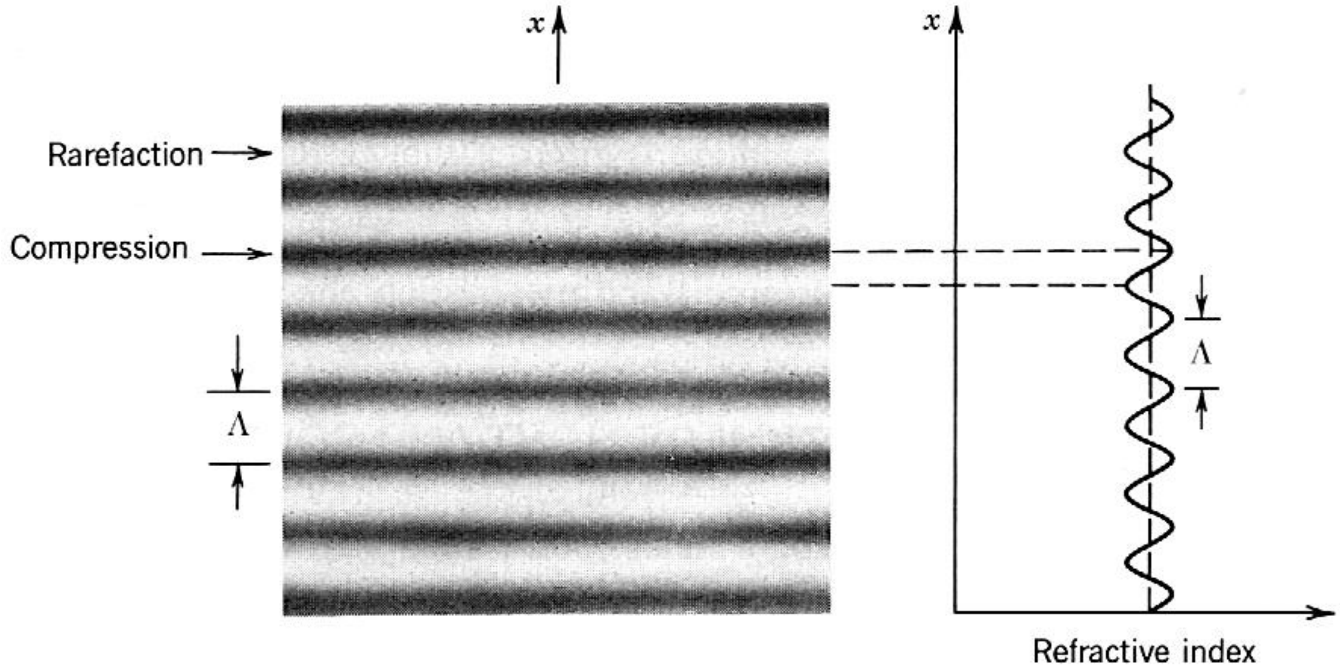
Interaction of sound and optical waves

Sound modifies the effect of an optical medium on light



Interaction of sound and optical waves

Variation of the refractive index accompanying a harmonic wave



Wave number: $$k = \frac{2\pi\nu}{c} = \frac{\omega}{c} = \frac{2\pi}{\lambda} \qquad (1)$$

where $$c = \frac{c_o}{n} \quad for \quad n \geq 1 \qquad (2)$$

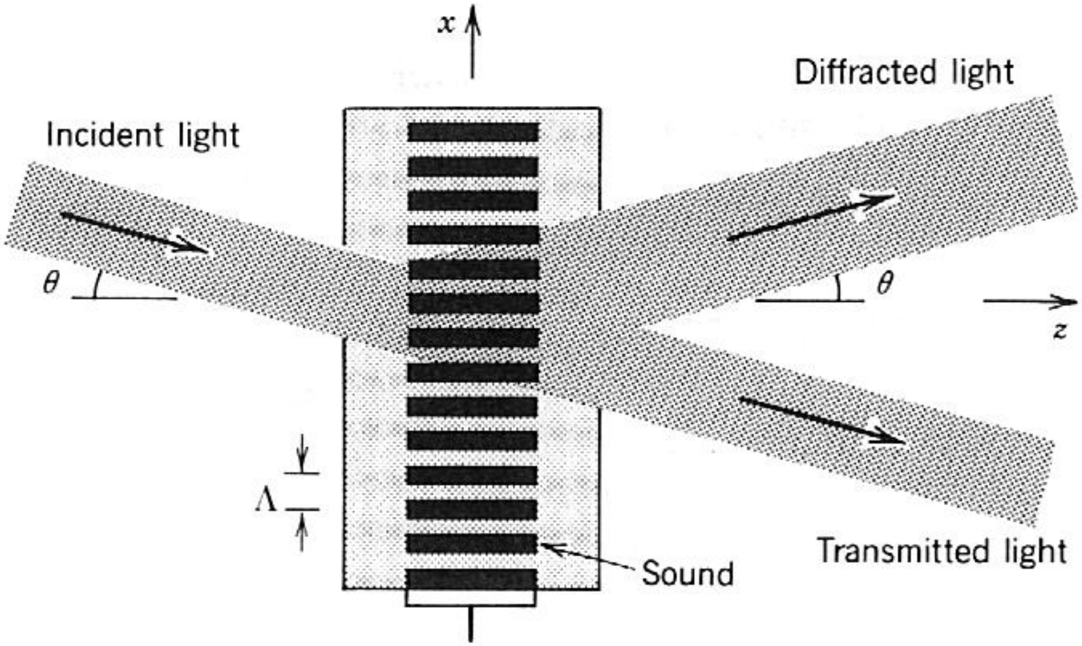
in which c_o is the speed of light in free-space and the wave propagates in a medium with index of diffraction n.

Interaction of sound and optical waves

Bragg diffraction:

An acoustic plane wave acts as a partial reflector of light *when the angle of incidence θ satisfies the Bragg condition*

Bragg condition of constructive interference (review in class):	$\sin\theta = \frac{\lambda}{2\Lambda}$	(3)



Interaction of sound and optical waves

Temporal heterodyning

If the two beams, diffracted and transmitted, are recombined:

$$U_o = A_o \exp(-j\phi_o) \qquad (4)$$

$$U_r = A_r \exp[-j(\phi_r + \omega t)] \qquad (5)$$

Resultant interference pattern becomes (review in class):

$$I(t) = (U_o + U_r)\cdot(U_o + U_r)^* \qquad (6)$$

Temporal heterodyning

Two reference beam setup for double exposure temporal heterodyning