Introduction: Temporal Heterodyning
24 November 2014
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:

\[ k = \frac{2\pi v}{c} = \frac{\omega}{c} = \frac{2\pi}{\lambda} \]  \hspace{1cm} (1)

where

\[ c = \frac{c_o}{n} \quad \text{for} \quad n \geq 1 \]  \hspace{1cm} (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 $\theta$ satisfies the Bragg condition.

Bragg condition of constructive interference (review in class):

$$\sin \theta = \frac{\lambda}{2\Lambda}$$

(3)
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If the two beams, diffracted and transmitted, are recombined:

\[ U_o = A_o \exp(-j \phi_o) \] \hspace{1cm} (4)

\[ U_r = A_r \exp[-j(\phi_r + \omega t)] \] \hspace{1cm} (5)

Resultant interference pattern becomes (review in class):

\[ I(t) = (U_o + U_r) \cdot (U_o + U_r)^* \] \hspace{1cm} (6)
Temporal heterodyning

Two reference beam setup for double exposure temporal heterodyning