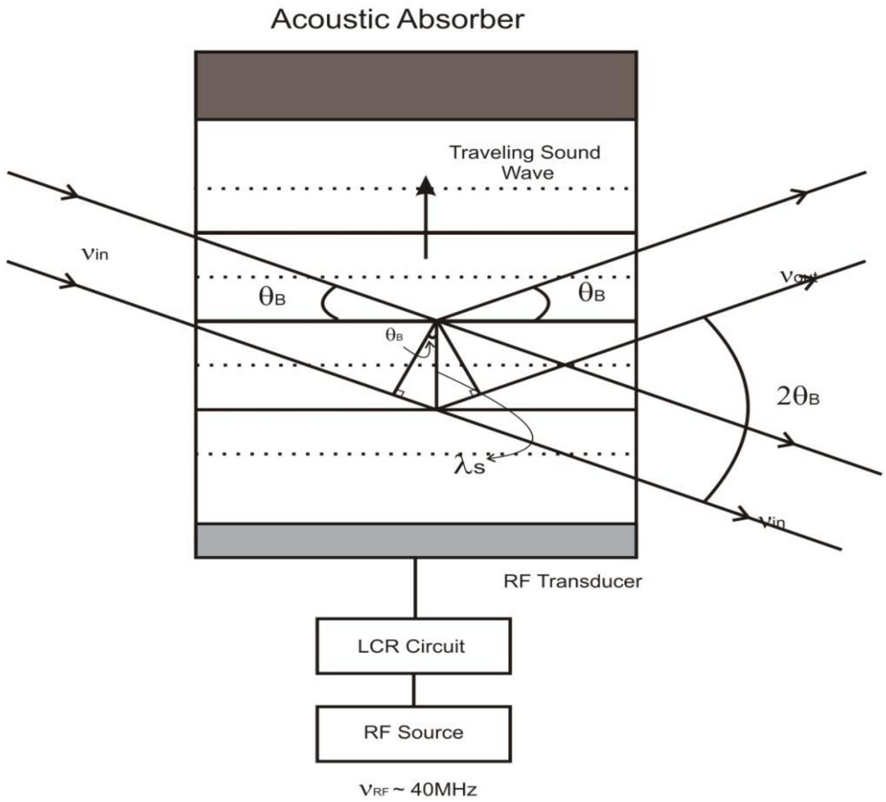
Phys 4061/5061 – Tutorial Five

Details Pertaining to laboratory experiments covered in this tutorial can be found in the lab manual under the following sections

1. AOM
2. Detectors

Acousto – Optic Moduators



- sound waves --> $\nu = \nu_{RF}$; Speed v_s ; wavelength λ_s such that $v_s = \nu_{RF}\lambda_s$
- λ_s is the wavelength in the crystal
- v_s is the speed of sound within the crystal – a property of the material

Traveling Sound Wave

- compressions / rarefactors
  - pressure waves
    - index of refraction, n, is modulated by the sound wave and the modulators act as a grating for light

Bragg Reflection of Light

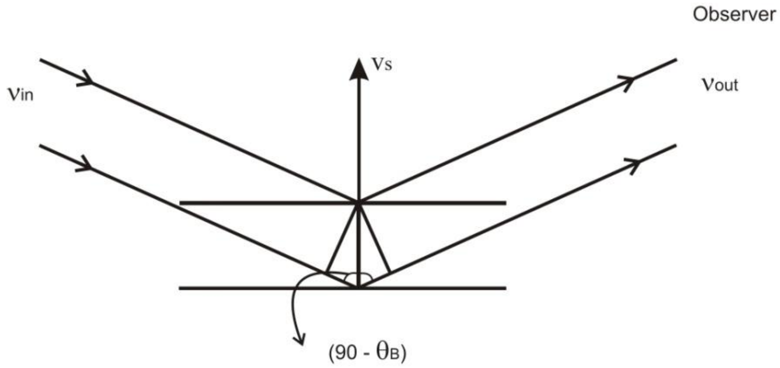
- incident light interacts with broad sound wavefronts
- have to tilt AOM to meet condition for Bragg scattering (or tilt laser)
- sound waves act like mirror
- θ_B is the Bragg angle
- Note: Diffracted beam is frequency shifted $\nu_{out} = \nu_{in} \pm \nu_{RF}$

$\boxed{\sin\theta_B = \frac{m\lambda}{2\lambda_s}}$ defines the Bragg condition for constructive interference

Applications

- frequency shifters/scanners/beam deflectors
- frequency modulators
- amplitude modulators/switches

Why the Frequency Shift? → Doppler Shift



- Frequency of light seen by frame attached to sound wavefronts

  $$\nu' = \nu_{in}\left[1 + \frac{v_{rel}}{c}\right]$$

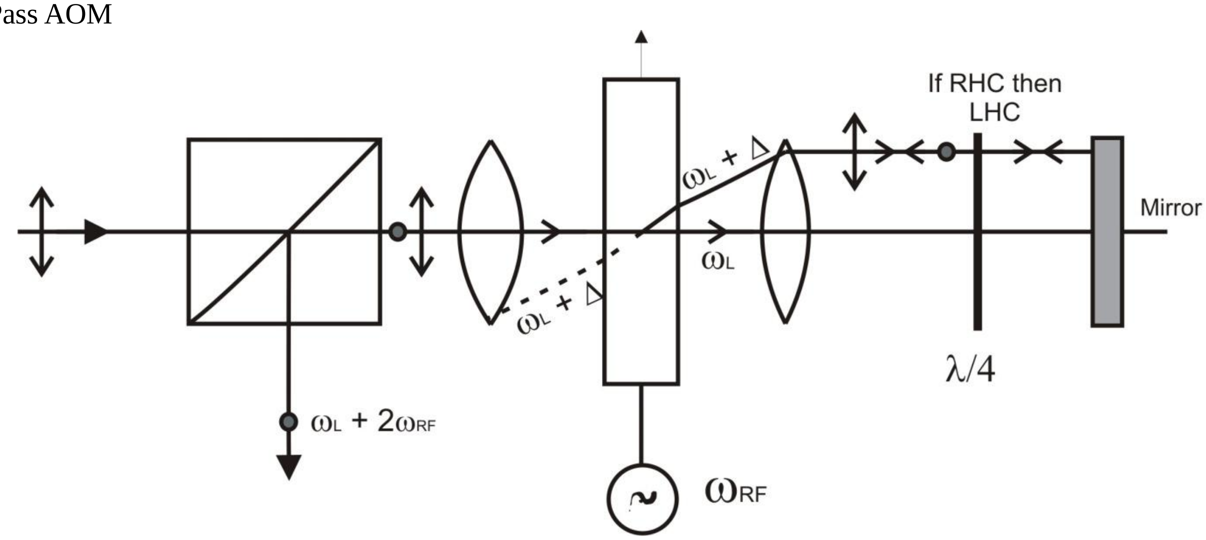
  $v_{rel} = v_s \sin\theta_B$

  $$\frac{\nu' - \nu_{in}}{\nu_{in}} = \frac{v_s \sin\theta}{c}$$

- Frequency of light seen by observer

  $\boxed{\nu_{out} - \nu_{in} = m\nu_{RF}}$ since $\frac{m\lambda}{2\lambda_s} = \sin\theta_B$ and $\nu_s = \nu_{RF}\,\lambda_s$

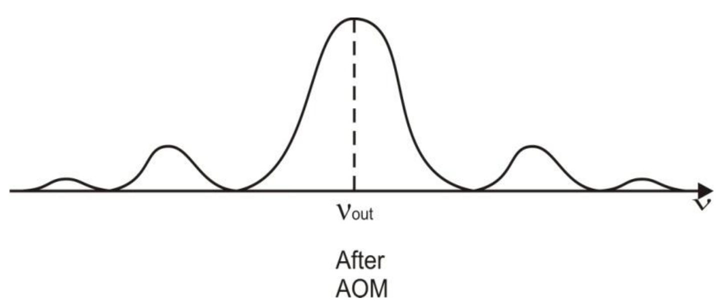
Dual Pass AOM



- For Frequency shifter applications

  $\sin\theta = \frac{m\lambda}{2\lambda_s}$ defines change in angle

  Change in angle can be avoided in dual
pass configurations



- Note: AOM --> Pulsing --> Produces spectral bandwidth

  $\nu_{out} = \nu_{in} \pm \nu_{RF}$