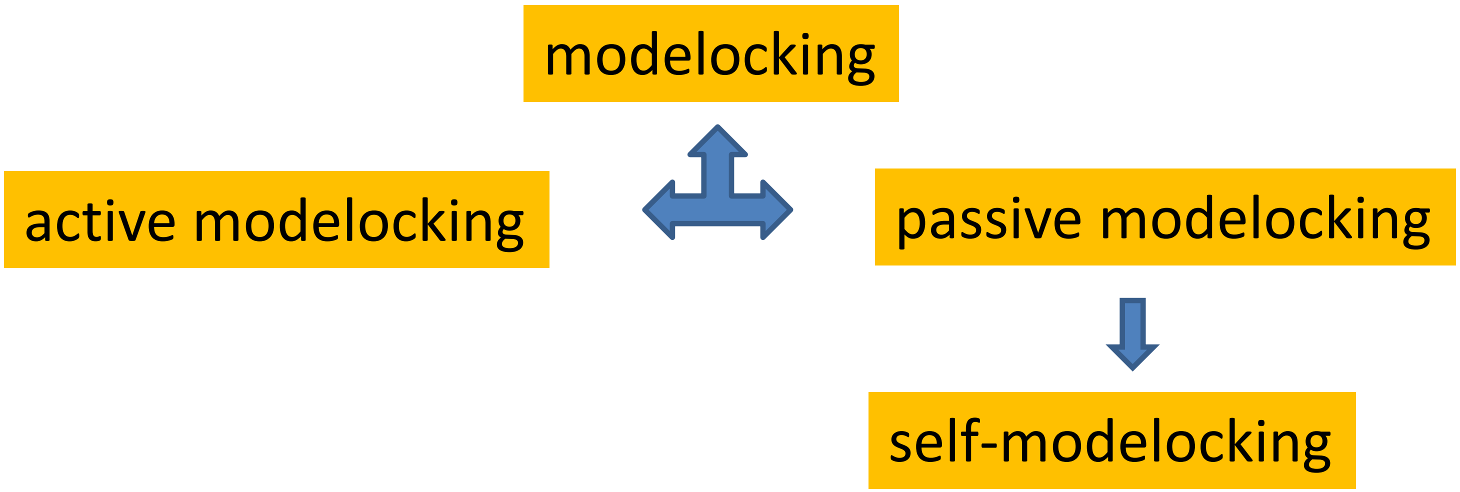

modelocking
active modelocking
passive modelocking
self-modelocking

The modulation of the optical resonator parameters with the frequency $\Delta\omega_q$ can be obtained in a variety of methods including:

a) acousto-optic devices which produce a sound-wave, modulating the laser beam's intensity propagating through a resonator;

b) electro-optical modulators driven at exactly the frequency separation of the longitudinal modes, $\Delta\omega_q$;

c) the *saturable absorbers* modulating the amplification factor of an active medium.

The first two methods belong to the active modelocking methods, whereas the last represents the passive modelocking.

What is the mechanism which causes the randomly oscillating longitudinal modes to begin oscillating in synchronised phases, under the influence of the modulating factor, at the frequency $\Delta\omega_q$?

This can be achieved only when the longitudinal modes are coupled together.

When we modulate the amplitude or frequency of a given longitudinal mode of frequency ω_0, with the modulation frequency Ω, an additional radiation component appears at $\omega_0 \pm n\Omega$.

If the modulation frequency Ω is equal to the frequency-separation, $\Delta\omega_q$, of the longitudinal modes, these additional components overlap with the neighboring modes, causing coupling of the modes and stimulating oscillations in the same phase.

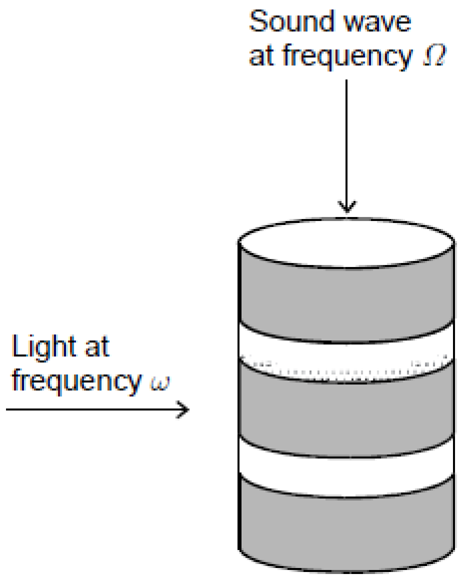
Basic aspects of frequency- or amplitude modulation.

In the first method, (a), an acousto-optic transducer generates a sound wave that modulates the amplitude of the laser beam in the optical resonator.

Understanding of the mechanisms governing the interactions between light and sound waves is very important, since the acousto-optic devices are often used in laser technologies—not only for modelocking, but also in pulse-selection (cavity dumping) and in the Q-switching amplification.

If a transducer emitting ultrasonic waves at frequency Ω in the range of megahertz is placed in a glass of water illuminated with a laser beam of frequency ω, one notices that the light passing through the glass splits into several beams.

At each side of the fundamental beam, which is unaffected in frequency ω and direction, one observes side beams having frequencies $\omega \pm n\Omega$.



Debye - *Sears* effect

similar to light diffraction by a slit

Sound wave is a longitudinal wave

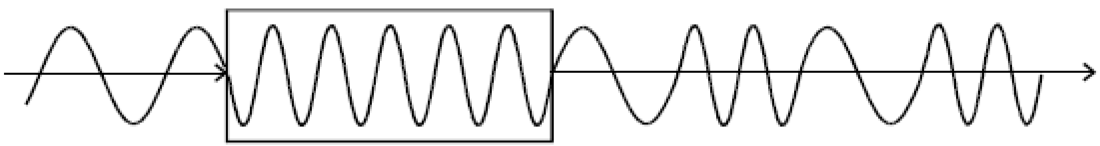
its propagation occurs by creating regions of different density

the regions of dilation can be treated as the slits through which more light passes than through the regions of greater density.

Nice similarity with diffraction of light! BUT

why do the frequencies $\omega \pm \Omega$, $\omega \pm 2\Omega$, $\omega \pm 3\Omega$,…. appear???

Let's imagine that light of frequency ω arrives at a medium characterised by a refractive index n_1



If $n_1 > n_0$, the light in the medium travels n_1/n_0 times slower (since $\lambda\nu = c' = c/n$)

Let's assume that we have some way of modulating the refractive index, n_1, with frequency Ω.

causes the light in the medium to propagate faster or slower, and the output light from the medium is also modulated The output light is characterised by the carrier frequency, ω, of the incident light and a side frequency of Ω leading to the appearance of additional components at frequencies of $\omega \pm n\Omega$