

The beat signal is 
$$i(t) = \text{constant} \cdot (|E(t)|)^2$$

$$(|E(t)|)^2 = E(t) \cdot c.c = E_1^2 + E_2^2 + 2 \cdot \cos[(\omega_1 - \omega_2)t + (\phi_1 - \phi_2)]$$

This shows the existence of the beat signal from a square-law detector

Each mode oscillates near a frequency 
$$\nu_m = \frac{m \cdot c_0}{2 \cdot n \cdot l}$$

but is "pulled" in towards the line center

Draw a diagram showing this.

If beats are observed at frequencies of 500MHz, 1GHz, and 1.5GHz, then there are four modes oscillating and

$$\frac{c}{2 \cdot l} = 500 \cdot 10^6$$

This is a gas laser so we can use  $c = c_0 = 3 \cdot 10^8$

$$l := \frac{3 \cdot 10^8}{2 \cdot 500 \cdot 10^6}$$

$l = 0.3$  cavity length is 0.3m

If the pressure is increased, then the homogeneous contribution to the lineshape grows and mode competition kicks in. If a beat is only observed at 1GHz, then every other mode has been suppressed and only two modes separated by 1GHz are still oscillating.