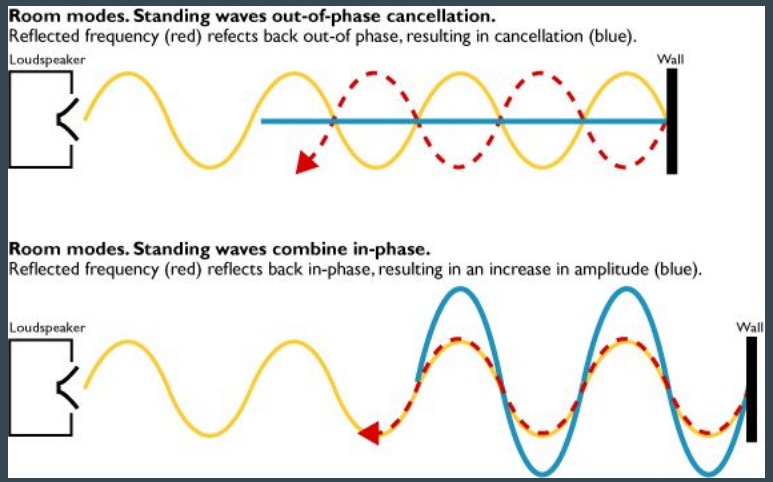
Room Acoustics

A presentation by Ethan Harte

The Ideal Listening Experience

The speaker is the only sound the listener should hear.

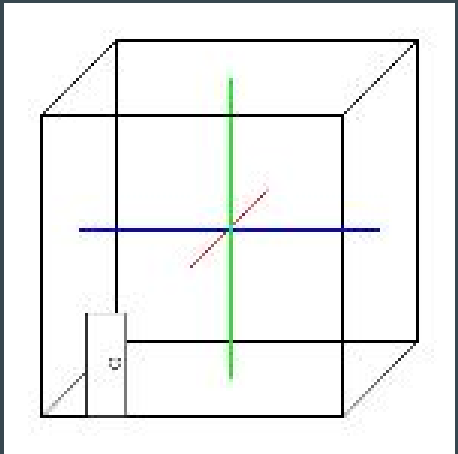
Standing Waves (Room Modes)



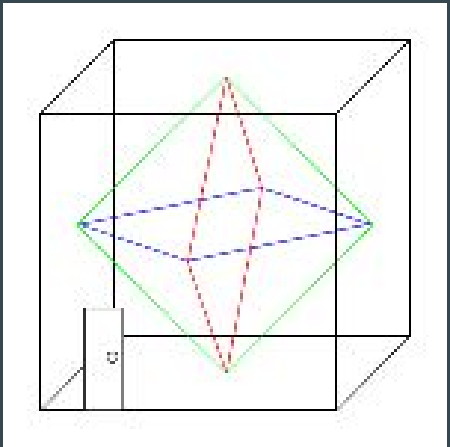
Standing Waves:

- *Deconstructive interference* eliminates certain frequencies
- *Constructive interference* amplifies certain frequencies and can cause *ringing*, which is when the signal has some decay time.

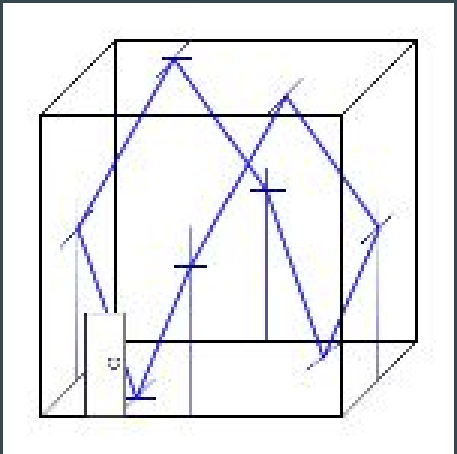
Types of Room Modes



Axial Modes



Tangential Modes

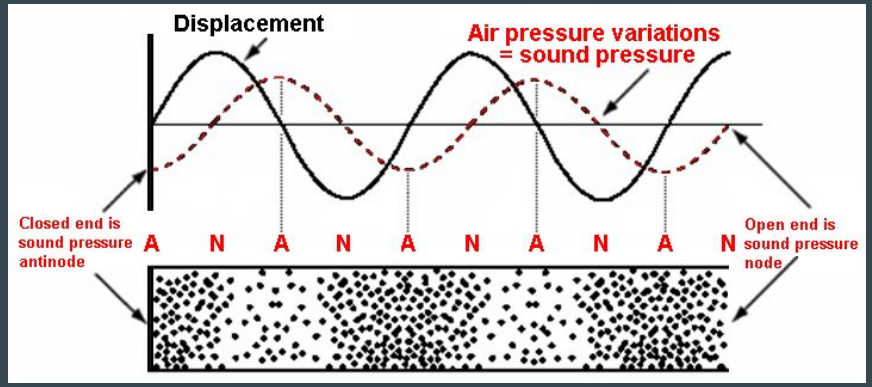


Oblique Modes

Room Mode Frequencies Occur at:

$$f = \frac{c}{2}\sqrt{\left(\frac{n_x}{L}\right)^2 + \left(\frac{n_y}{W}\right)^2 + \left(\frac{n_z}{H}\right)^2}$$

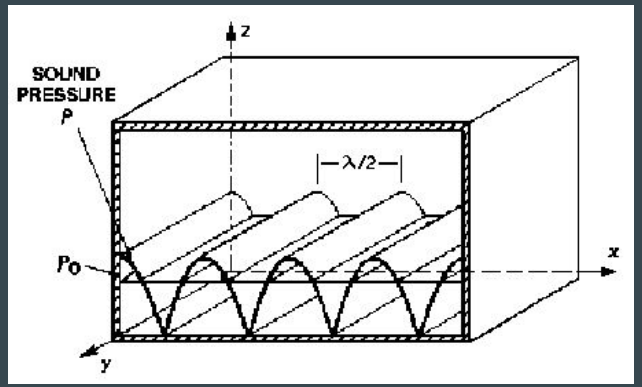
How do Room Modes Affect Sound?



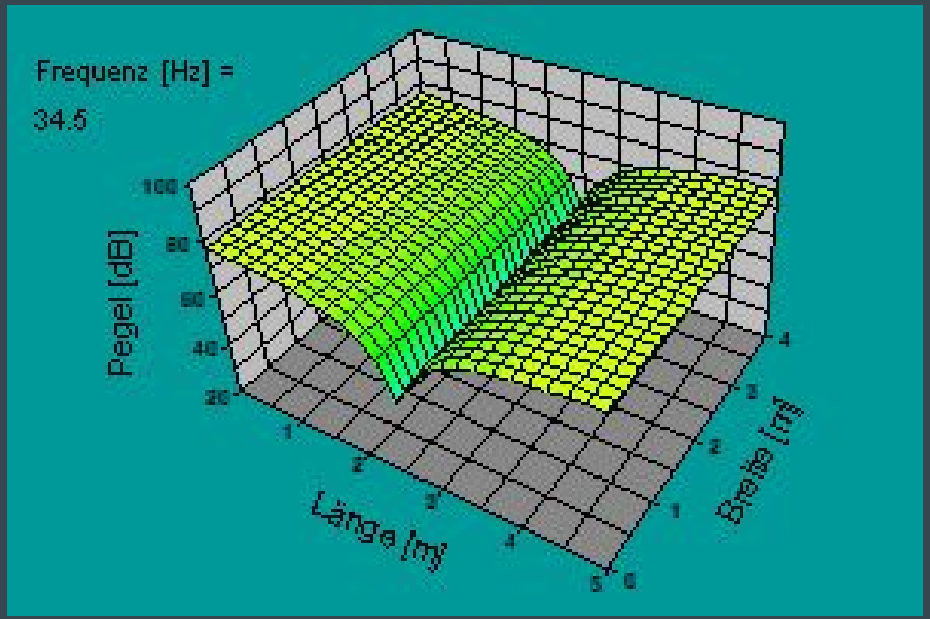
Sound Pressure Vs. Sound Displacement:

- Maximum pressure occurs when the air particles are either very dense or very sparse.
- Maximum displacement occurs when a particle has been moved the farthest from it's original location.

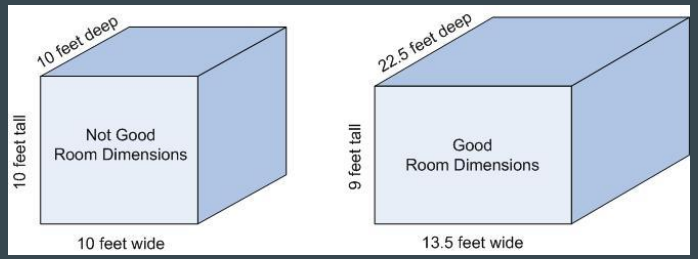
We hear sound pressure, not sound displacement.



Sound Pressure Inconsistencies



Solution?



Avoid Rooms with a L, W, and H that are multiples of each other.

This is to avoid having the same frequencies become room modes for each axis in the room.

“Bolt Area” Chart:

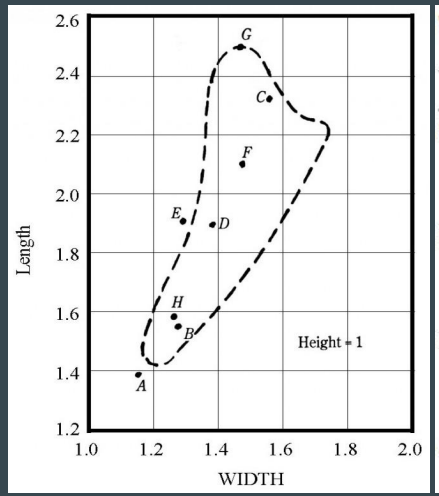
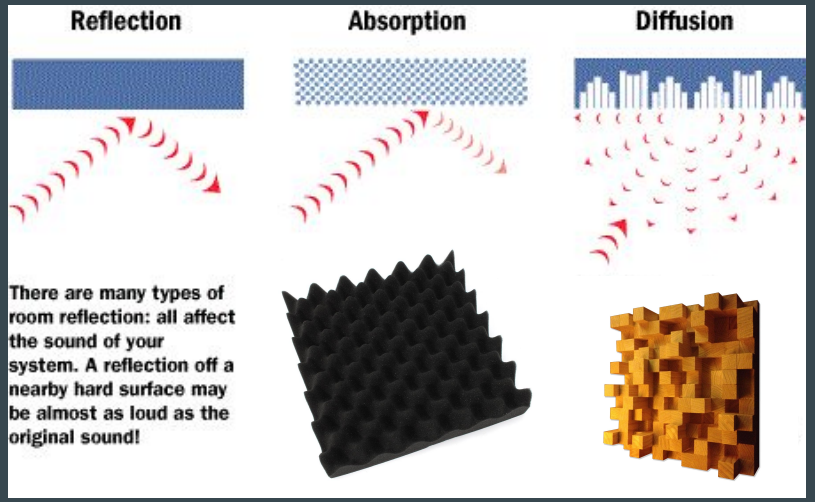


Table 13-2. Rectangular room dimension ratios for favorable mode distribution.

Author		Height	Width	Length	In Bolt's range?
1. Sepmeyer[5]	A	1.00	1.14	1.39	No
	B	1.00	1.28	1.54	Yes
	C	1.00	1.60	2.33	Yes
2. Louden[6]	D	1.00	1.4	1.9	Yes
3 best ratios	E	1.00	1.3	1.9	No
	F	1.00	1.5	2.5	Yes
3. Volkmann[3] 2 : 3 : 5	G	1.00	1.5	2.5	Yes
4. Boner[4] $1: \sqrt[3]{2}: \sqrt[3]{4}$	H	1.00	1.26	1.59	Yes

Solution?



Room Treatment:

- *Absorption material* can be placed to reduce reflections. This reduces the room mode effects as well as reducing unwanted delay/echo.
- *Diffusion material* is useful because it can reduce the listener's ability to be able to pinpoint a reflection.

Bass Traps are a type of absorption material designed for low frequencies. They are usually placed in corners since the sound pressure level of low frequencies builds in corners.

References

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