**<u>The Sound Field In Small Listening Rooms</u>:**

We can walk blindfolded into any room and very quickly, *qualitatively* assess that room's sound characteristics, because the neural sound processing center(s) in our brains have been programmed by years of auditory experiences to do so. When first-reflected sounds follow closely on the heels of the direct sound, an auditory impression of smallness is created, whereas if they arrive commensurately later, as in the case of an auditorium or concert hall, a feeling of spaciousness is created. Various attempts have been made at creating some of the acoustic features of a concert hall in a home listening room, *e.g*. using stereophonic expanders, electronic reverberation, *etc*. Placing additional speakers in the room also can help to create a feeling of spaciousness to some degree, since then direct sound arrives from several directions, rather than just two.

As mentioned/discussed earlier, in a small listening room, at low frequencies, nearly all listeners are in the reverberant sound field, whereas at high frequencies, the effect would depend on where the listener was seated – closer (or not) to the direct sound(s) emanating from the *L*/*R* stereo speakers, somewhere along the median plane between the speakers in the above figure.

This problem is compounded by the fact that in small listening rooms, due primarily to carpeting on the floor, the sound absorption *A* of the room is greater at high frequencies. While the spatial location of the sound "image" is determined by the precedence effect in association only with the direct sound(s) from the *L*/*R* stereo speakers, the <u>tonal</u> <u>balance</u> perceived by the listener appears to be derived from the <u>total</u> <u>sound</u> heard by the listener. This implies that the sound heard in the room is best described by the *power* radiated by each speaker at a given frequency, $dP(f)/df$ (*Watts*/*Hz*), rather than the {on-axis} sound pressure level, $SPL = L_p$ (*dB*).

In experiments measuring and comparing the acoustic spectral characteristics of high-quality hi-fi stereophonic sound reproduction systems in small listening rooms to actual concert halls, the mid-band (250-2500 *Hz*) characteristics were found to be comparable, whereas below 250 *Hz*, the low-frequency spectral response of the stereo hi-fi system in small listening rooms was significantly below that of the concert halls, attributed to inadequate stiffness of the walls, windows, etc. of the small listening room, which causes them to absorb low-frequency sound by vibrating sympathetically. At high frequencies, the average sound levels in small listening rooms was higher than in concert halls. Thus, these experiments suggest that in order to emulate the tonal balance heard in a concert hall, the *EQ* of a hi-fi stereophonic sound system in a small listening room should be boosted in the lower frequencies, and cut somewhat at the higher frequencies.

As also mentioned earlier, placing the speakers in the corners of endwall of the small listening room will preferentially help boost the low frequencies, since the corners of the room are pressure anti-nodes of the various room modes, by as much as ~ 9 *dB* in some situations. The corner walls + floor (or ceiling) of the room form a sort of frequency-dependent pyramidal horn that increases the efficiency of sound radiation at low frequencies. The frequency-dependence can be minimized by placing the loudspeaker such that the distance from the woofer cone to nearby walls – *i.e*. reflecting surfaces differ by at least a factor of 2× {*n.b*. this is also important for placement *e.g*. of bass guitar amp speaker cabinets, for gigs in smaller venues…}