To summarize the above discussion of various types of sound absorbers, and to further clarify their generalized principle of operation: ***any*** type of acoustic resonant cavity (or structure) can be modified for use as an acoustic resonant absorber – this statement has far reaching consequences.

You may have learned *e.g.* in an *E&M* physics course that "a good (poor) emitter of radiation is also a good (poor) absorber of radiation", perhaps in the context *e.g.* of black body/thermal radiation. Precisely the same statement is applicable for acoustic radiation!

Why is this true? It is due to the fact, that at the microscopic level, sound waves/sound vibrations of any/all kinds manifestly (also) involves the electromagnetic (*EM*) interaction of atoms and molecules with each other, just as black body/thermal *EM* radiation does.

A fundamental symmetry property of the *EM* interaction, at the microscopic level {*i.e.* the exchange of virtual photons between electrically charged particles – here for acoustics, between atoms and molecules, even if overall they are electrically neutral – they are composite particles made up of point-like negative-charge electrons and positive-charge nuclei} processes involving the *EM* interaction manifestly obey time-reversal invariance – *i.e.* the picture (or movie) of an *EM* process running backwards in time is *indistinguishable* from that for the same process running forwards in time. Hence, here in an acoustical physics setting, it can be seen that an efficient radiator of sound energy will also be/can be made to be an efficient absorber of sound energy, because of/due to the manifest time-reversal invariant nature of the *EM* interaction at the microscopic scale. This may seem to be trivial statement, but it in fact is by no means the case, since we know of another fundamental force of nature – the weak interaction (*e.g.* responsible for radioactivity/beta-decay of nuclei) which manifestly violates time-reversal invariance in certain situations – *e.g.* the weak decays of neutral *K* and *B* mesons!

Home Theater & Surround-Sound Systems:

For today's home theater, their design is such that typically the room used for home theater entertainment is systematically somewhat larger than that of the average hi-fi home listening room, however such rooms are still small in comparison to concert halls, auditoriums, etc. Acoustically, the goal of a home theater is to replicate that of a commercial movie theater, which often uses the 5.1 surround-sound system – hence home theaters will have this also.

The 5.1 surround-sound system uses 5 separate loudspeakers – left, right, center, left surround and right surround, and a subwoofer (the .1 of 5.1). The center speaker is optional in some 5.1 S-S recordings, but is important in motion pictures, *e.g.* for speech dialog between characters/actors.

For hi-fi stereophonic home listening rooms, we discussed the importance of the listener being in the "sweet spot" of the sound "image", located on the median plane between the *L* & *R* speakers (*p.* 12 of these lecture notes / Fig 25.9 *p.*578 of SoS textbook). In home theaters, this is impractical (as it is in commercial movie theaters) because there often are many people wanting to watch a movie, and they all can't fit into the "sweet spot" together/at the same time. This is precisely why the center speaker in 5.1 S-S is used primarily for speech dialog – it is centrally localized.