Task 5

Measurement with omni-directional source

5.1 Task

1. Measure sound field generated by omni-directional sound source in enclosed space. For excitation use band pass noise in four selected third-octave bands.
2. From measured decays estimate reverberation time for selected bans.

5.2 Theory

Sound field where sound propagates without any reflection is called *free field* (sometimes free space). In such field spherical waves propagate uniformly out of the centre and sound pressure level decreases of 6 dB when the distance is doubled. In enclosed spaces (rooms) this law is valid in limited area around the source, farther from the source the reflections from the walls will dominate. In this area it is impossible to find the direction of propagation of the sound and generally the sound is coming from all directions with the same probability. This kind of sound field is called *reverberant field* or *diffuse field. Reverberant radius* r_d (see figure 5.1) is defined as a distance from the source where the contributions from direct and reverberant field are equal and can be assumed as a boundary between free field and reverberant field.

$$r_\mathrm{d} = 0{,}057\sqrt{\frac{V}{T}}\ , \tag{5.1}$$

where V is volume of the space and T is reverberation time. Note that reverberant radius (as well as reverberation time) is frequency dependent.

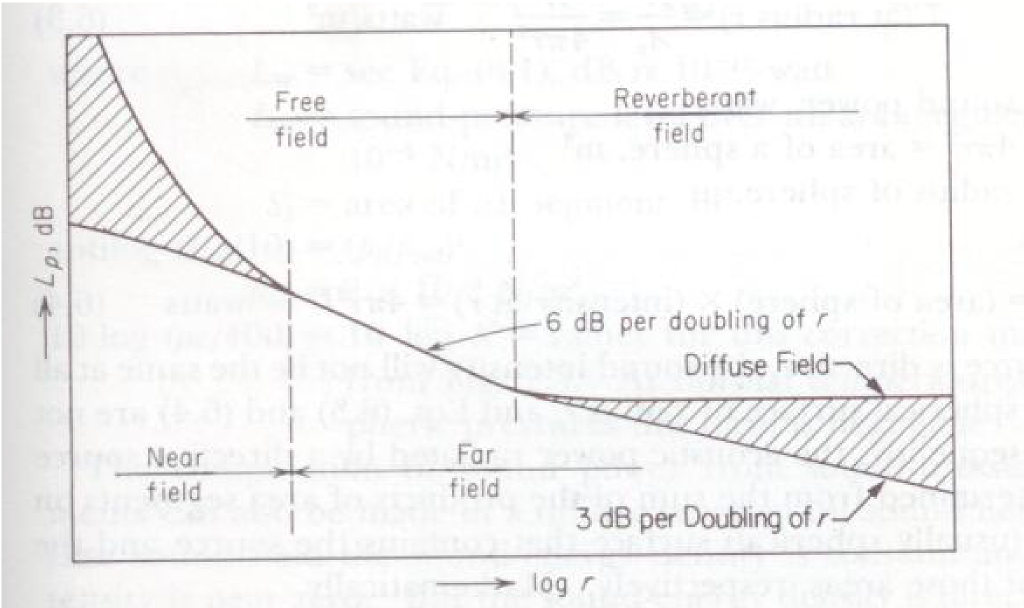
In the sound field near to the source we can define *near field* where the sound pressure and particle velocity are nearly out of phase. The boundary between near field and *far field* is assumed in distance of

$$l < \frac{c}{2\pi f}\ , \tag{5.2}$$

where c is speed of sound in the environment and f is frequency. Note that this boundary is not very sharp but gradual transition. In enclosed spaces this far field is then divided into free field and reverberant field depending on reflection from the walls.

5.3 Measurement procedure

1. For sound generation use CD with four tracks containing four signals – third-octave band noises with center frequencies of 250 Hz, 500 Hz, 1 kHz a 2 kHz. Each track contains 30 s of the signal followed by 10 s of silence.
2. At the amplifier set the signal level so that it is at least 10 dB above background noise in all measurement points but not to exceed 85 dB in the closest measurement point. Do not overexcite power amplifier and omni-directional source!



Obrázek 5.1: Sound field around the source

3. Set the sound level meter to Slow response and third-octave band filter to the frequency corresponding to the used signal. Measure equivalent level of sound pressure at distance of 30 cm from the omni-directional source center. For each frequency band measure at least 10 s.

4. Previous measurement repeat for the distances of 40 cm, 50 cm, 75 cm, 100 cm and then with step of 50 cm up to the total distance of 5 m from the omni-directional source center. Do not change the level set on amplifier during whole measurement.

5. Plot the graph of the level as a function of distance from the omni-directional source center (use logarithmic scale on the distance axis) and try to estimate reverberation radius.

6. Try to estimate reverberation time of the space assuming the space dimensions 6 m×6 m×4 m[1].

7. Conclude the measurements.

5.4 List of equipment

- omni-directional source
- Sound level meter Rion
- Amplifier QSC, typ RMX 1450
- CD player

[1]Taking into account that the room does not have two walls it is reasonable to assume larger dimensions as 12 m×8 m×4 m.