Abstract

Reverberation chambers are an essential laboratory facility for measuring the statistical absorption coefficient of acoustic materials. The validity of the measurements, however, depends critically on the diffusion of the sound field in the test chamber. There is now clear evidence that reverberation-room measurements of absorption coefficients produce systematic errors, generally attributed to a lack of diffuseness of the sound field. In particular, the procedure fails to yield consistent absorption coefficients across chambers, due to differences in the sound fields established in each particular room. The way in which these sound fields depart from an ideal state of diffusion is not yet understood. In fact, the lack of experimental methods to analyze the sound field in reverberation rooms hinders our ability to explain the differences between each sound field, and how they deviate from a diffuse field.
This PhD study investigates sound field analysis techniques for the characterization of reverberation chambers. The directional properties of the stationary and decaying sound field in reverberation chambers are examined experimentally in two ways: (i) by analyzing the distribution of sound energy in the plane wave expansion of the sound field (i.e. in the wavenumber domain); and (ii) by analyzing the distribution of net intensity throughout space. It is shown that the directional properties of the reverberant sound field can be described based on an analysis of the wavenumber spectrum in the spherical harmonics domain, which leads to a characterization of the isotropy of the wave field. Further, a methodology is introduced that can extract the incident intensity field on the measuring sample, enabling to characterize the coupling between the absorptive material and the sound field above it. Additionally, the net flows of acoustic energy are analyzed, and structural differences identified between occupied and empty reverberation rooms, which are accentuated in the decay process.
It is the purpose of this dissertation to examine and discuss the relevant findings, and review the contributions of the PhD study in relation to the existing body of knowledge.

Keywords: reverberation chambers; measurement of sound absorption; sound field diffusion; plane wave decomposition; intensity; microphone arrays.