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DEVELOPMENT OF ACOUSTICS AT THE NEW UNIVERSITY OF OLDENBURG

Volker Mellert* **Steven Van de Par**
Carl von Ossietzky University, Medical Physics and Acoustics, Acoustics Group
26111 Oldenburg, Germany

ABSTRACT

In the 70s, new universities were founded in Germany, including in Oldenburg (1974). In order to prepare for teaching and research, planners from traditional universities had to support these new universities. Oldenburg received support from scientists from the renowned ”Drittes Physikalisches Institut” (Göttingen), which covered subjects from room acoustics to high-frequency ultrasound, and in 1975, Volker Mellert moved from Göttingen to a professorship in Oldenburg. One goal of the new university was practical training and research for the well-being of the people. Together with the planner Ulrich Radek, a unit ”Acoustics” was founded within the Physics Department. This newly founded Acoustics Group started research on environmental noise, in particular industrial and traffic noise. Measurements were carried out with students on real objects outdoors and evaluated in the laboratory. Many years of research into outdoor wave propagation, and the perception of sound followed. Research in the broader field of acoustics was significantly expanded with the appointment of Birger Kollmeier (1992), and the Acoustics Group participated in Collaborative Research Centres and a Cluster of Excellence (2018) on Hearing Research. The Acoustics Group became part of the new ”Department of Medical Physics and Acoustics”, now headed by Steven van de Par since 2010.

Keywords: *Oldenburg, acoustics, sound propagation outdoors, hearing research, psychoacoustics.*

**Corresponding author*: *volker.mellert@uol.de*

1. INTRODUCTION

At the beginning of the 1970s, there were a number of new universities planned in Germany. In Lower Saxony, universities were founded in Oldenburg, Osnabrück and Lüneburg with the aim of enlarging the educational offer in the area. Traditionally, in Lower Saxony there was only one general university in Göttingen, and technical universities in Braunschweig, Clausthal and Hannover, whose range of subjects was later expanded. To prepare for the start-up, scientists were sought who, as planners, would prepare both the appointment of the first professorships and the subject-related infrastructure. Staffs were often recruited from established universities of the Federal State, respectively. From the renowned "Drittes Physikalisches Institut" of the University of Göttingen (M.R. Schroeder), came to planning the subject physics Dr. F. Bader (laser physics, applied optics) and Dr. U. Radek (ultrasound, cavitation) and to establish the university computer centre Dr. B. Wagener. Implicitly a slight tendency for applied physics and signal processing was predestined. An orientation on laser physics and spectroscopy was achieved through the appointments of Dr. J. Luther (Hannover) and Dr. K. Maier (Regensburg) for the first professorships in experimental physics. Later, the internationally renowned focus of the university in "renewable energy" was promoted by the work of Prof. Luther.

2. STUDY PROGRAM

When the university was founded in 1974, a so-called "project-oriented" study program was planned that takes up practical problems as early as possible in the training and uses them to convey the professional basics. Related to the fact that at this time some younger scientists became aware of the “Limits to Growth” (Club of Rome, 1972), planning in Oldenburg showed a certain orientation towards “environment” and “sustainability”. University education, research and development should help solve problems that people experience in an environment that is becoming increasingly less livable. "Acoustics" was identified in the physics planning as an appropriate approach to practical training. Volker Mellert moved from Göttingen to Oldenburg in response to a corresponding professorship vacancy. In the 1974/75 winter term, he planned a so-called project with U. Radek on the subject of "Noise". The content of the "scientific” part of “Noise” must be announced for the students of the summer term - the formal information read (original quote translated):

- Experimental study of the effects of noise on humans
- Development of easy-to-use measurement methods for noise assessment
- Signal analysis using electronic data processing systems
- Generalization of the mathematical signal description in application to other physical phenomena

A first outcome of the “Noise” project was the "Comparative assessment of traffic noise” [1] (in German).

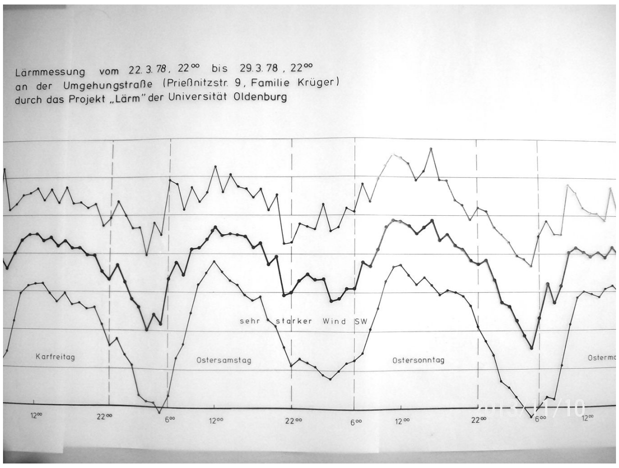

Figure 1. Section of a long-term traffic noise measurement in the shade of a noise barrier. Ordinate starting at 40 dB(A) in 5 dB steps. „Strong wind“ at night enhanced the immission by about 5 dB. (Student working group 1978).

One requirement of the project-oriented training was leaving the laboratory in order to carry out relevant investigations outside in the environment. A current project that time was the construction of a bypass autobahn in Oldenburg (including noise barriers) in the 1970s. It made sense to carry out long-term measurements of the immission at a house near the motorway with a student working group, and to analyze the level reduction by the noise barrier (Fig. 1). Incidentally, a citizens' initiative "against noise" was supported by our measurements which led to fierce political disputes in the local newspaper, and provided the students with certain insights into social contexts. (The “project-oriented” study program should include social-related aspects.)

Physically, the course of the level values showed the clear dependency of the sound propagation on the weather conditions. In the years that followed, many studies of sound propagation outdoors were carried out in the Acoustics Group, e.g. development of a powerful impulse sound source and measurement of sound propagation outdoors, modelling noise propagation from high-lying sources, measurements of ground impedance, sound scattering through turbulence [2-4].

3. SOUND PROPAGATION OUTDOORS

In 1975, the university divided the growing natural sciences into the classical subjects of Biology, Chemistry, Mathematics and Physics. In physics, the working groups "Theory", "Laser Physics", "Spectroscopy", "Optics", "Didactics" and "Acoustics" were first defined, from which various departments later emerged. The first PhD student of the new Acoustics Group was W. Wilken, who experimentally investigated the fluctuating sound propagation in the atmosphere near the ground [5, 6]. The phenomena observed outdoors were studied in parallel in a model system in the laboratory by means of ultrasonic propagation through a thermal "phase screen" of fluctuating air [7].

One problem of the new university was the lack of suitable laboratory space. For investigations in acoustics, a room with highly absorbing walls was missing. A real anechoic chamber could only be realized with the move into the new buildings of the natural sciences in 1982. Before that, however, it was possible to raise funds for a small acoustic measurement room (lower cut-off frequency 125 Hz), which could then be erected in a separate building (Fig. 2). The new big anechoic chamber (Figs. 3 & 4) was 1982 built within the physics department, mounted on springs for vibrational damping, and with a true 50 Hz cut-off frequency[1]. The background noise lies well below the threshold of normal hearing, which allowed for a re-determination of the threshold in an international cooperation [8].

[1] Currently (2022), the large anechoic chamber has been renovated and provided with new absorption material and low-emission ventilation.

Figure 2. Small anechoic chamber of the Acoustic Group (about 1980) with R. Weber, W. Wilken, V. Mellert, U. Radek.

In addition to measurements of subjective acoustic perception, the size of the room also allows the measurement of the sound radiation of a source under free-field conditions. U. Radek developed a powerful electrical spark source for determining the acoustic transfer function of sound propagation outdoors under given "frozen" atmospheric conditions [9, 10]. The spark source provided a highly reproducible δ-impulse (Fig. 3). The optimization of the sound source could not be completed. U. Radek died in 1991 after a short, serious illness.

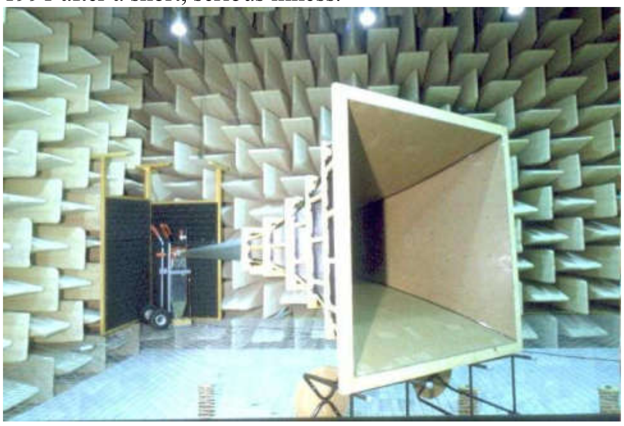

Figure 3. Acoustic δ-impulse spark source attached to a horn speaker.

The experimental studies on outdoor sound propagation were substantially supported by the dissertation projects in theoretical physics of Baowen Li[2] and R. Große[3] [11, 12], and the intense theoretical research of wave propagation in turbulence by the visiting scientist V. E. Ostashev[4] [13-15]. In addition, the problem can be inverted (cf. tomography): The acoustic measurement allows conclusions to be drawn about the profile of the speed of sound or the wind and temperature distribution as well as the structural parameters of the atmosphere [25-30].

4. IMPEDANCE

Another important parameter that influences sound propagation is the impedance of the boundary, in this case outdoors that of the ground. The wave propagation is strongly influenced by the (complex) ground impedance at grazing incidence. In the Acoustics Group, ground impedance was investigated in many research projects by measurements outdoors and theoretically for the effective modelling of sound propagation as well as for determining properties of acoustic material [16-24]. In the general case of grazing wave propagation along a boundary with the constraint of finite impedance, the wave can be described by a guided "ground wave", which leads to significant destructive interference with the free wave. The sensitive dependence of this interference on the nature of the interface opens up interesting measurement methods for material properties [31]. Depending on the geometric arrangement of transmitter and receiver, the first minimum of the ground wave interference changes in the (experimentally measured) transfer function. With this finding, we have proposed an acoustic underwater measurement method for the detection of drowned, fluid pollutants, since fluid pollutants deposited on the sediment are often not optically (i.e. spectroscopically) identifiable [32-34]. The measurement method was successfully tested in situ in a river, but not continued after the end of the project funding. The "excursion" of the Acoustics Group underwater led, among tackling other problems in technical acoustics, to the founding of the spin-off itap GmbH, which has since developed into a renowned measuring and consulting center for underwater sound, e.g. in monitoring the emission of marine structures[5]. The "Noise" project led not only to broad investigations of wave propagation but

[2] Now: https://faculty.sustech.edu.cn/?p=170792&tagid=libw&cat=2&iscss=1&snapid=1&orderby=date&go=1&lang=en
[3] Now: R. Wandelt, Jade Univ. Applied Science https://www.jade-hs.de/unsere-hochschule/fachbereiche/seefahrt-und-logistik/team/professor-innen/
[4] Now: University of Colorado Boulder:. https://www.researchgate.net/profile/Vladimir-Ostashev/2
[5] itap GmbH, https://www.itap.de/en/

also to numerous questions concerning the subjective perception of sound and vibration.

5. PERCEPTION OF SOUND AND VIBRATION

5.1 Graduate School Psychoacoustics

V. Mellert's experiences from Göttingen with subjective sound field recordings in head-related stereophony [35] for the investigation of concert hall acoustics initially led to an optimization of the manikin head microphone device in Oldenburg [36] to be used for the recording of environmental and industrial sound (or subjectively: noise) [37]. Fortunately, at the beginning of the new university in 1974, August Schick[6] was appointed to a professorship in psychology. Prof. Schick was interested in the perception of the environment by humans; he later founded the "Institute for the Study of Human-Environment Relationships". In 1975/76, soon after starting the "Noise" project in physics, A. Schick announced the seminar "Loudness and noise from a general and differential psychological point of view"(in German)[7], to which our physics students were sent. This was the beginning of a fruitful collaboration in acoustics between the subjects of physics and psychology. A. Schick built up an extraordinarily extensive literature database on psychological acoustics and organized ten international "Oldenburg Symposia on Psychological Acoustics" from 1978 to 2008, the results of which are documented and available in several 1000 pages[8]. During the symposia, the plan to establish a "Graduate School Psychoacoustics" with the claim "Auditory Signal Processing, Sound Evaluation and Sound Effect – Modelling of Basic Auditory Properties for Technical Applications and Clinical Use" was developed. The School started 1992, and has been extensively funded by the German Research Foundation DFG for 10 years. Significant personnel support in the application for the Graduate School Psychoacoustics was provided by the appointment of Dr. rer.nat, Dr. med. Birger Kollmeier, who had already established a strong working group on "Hearing Acoustics" at the "Drittes Physikalisches Institut" in Göttingen. Prof. Kollmeier succeeded in "relocating" his research group to the University of Oldenburg. Thus, the competence in acoustics in Oldenburg was not only doubled abruptly, but also expanded to include the medical aspect of hearing. The physics of hearing with the transmission of sound from the outer ear to the transformation into the neuronal representation of what is heard became a focus of "Medical Physics and Acoustics"[9] under the direction of B. Kollmeier. In 1996 he founded the "House of Hearing"[10], which became an important research and development center for hearing-related diagnostics.

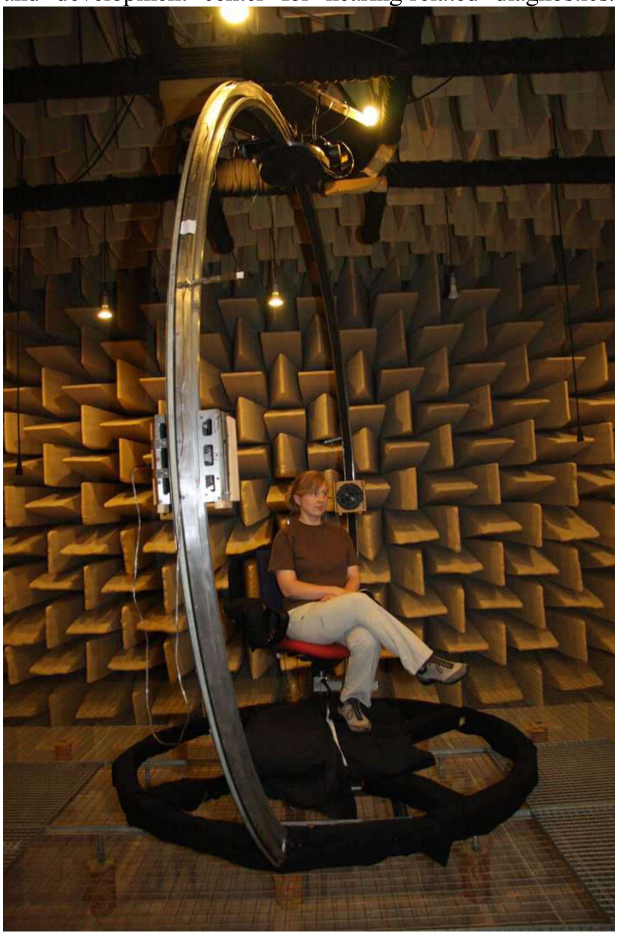

Figure 4. Investigation in directional hearing with moving speakers on rails in the large anechoic chamber.

The Graduate School Psychoacoustics can be considered one of the roots for later Faculty of Medicine at the university. In 1996, the scientists of the Graduate School, together with other colleagues from Biology and Psychology from Oldenburg and from the neighboring University of Bremen, founded the Collaborative Research Center 517 "Neurocognition" (until 2005), which became the essential basis for the establishment of the Faculty of

[6] https://de.wikipedia.org/wiki/August_Schick
[7] Lautheit und Lärm aus allg. u. Diff.-psychol. Sicht
[8] https://uol.de/psychologie/emeriti/august-schick#ospa (section „Publikationen“)

[9] https://uol.de/en/mediphysics-acoustics
[10] https://www.hz-ol.de/en/house-of-hearing.html

Medicine in Oldenburg. Research in the Graduate School led to many doctoral theses; the results have been presented at international congresses and published in scientific journals, e.g. [38-40]. All graduates and publications are listed in Prof. Schick's aforementioned database. A further report on the Graduate School Psychoacoustics exceeds the given number of pages.

5.2 Applied Psychoacoustics

In addition to research in sound propagation, directional hearing and psychoacoustic parameters in connection with subjective loudness, technical sounds and vibrations were investigated in the Acoustics Group in order to characterize their subjective perception by suitable parameters and making them measurable with the help of a functional model, e.g. [41,42]. It is of particular interest to quantify how the perception of sound and vibrations contributes to the reduction of comfort at work, during travel or generally to the annoyance in the respective individual environment [43-45]. A significant disturbance in comfort is caused by structural vibrations. For the quantitative measurement of the frequency-dependent perception of whole-body vibrations, a special vibration laboratory with vibration shakers and sensors was set up in the Acoustics Group. Michael Bellmann investigated the fundamentals of vibration perception in his dissertation thesis [52].
Travel comfort is an important factor in competition, e.g. in air travel. This aspect was investigated in several large European projects in which the Acoustics Group was involved. Vibro-acoustics were a major issue in IDEA PACI [57,58], HEACE[11][46-51], and in FRIENDCOPTER with psychoacoustic questionnaires [59,60]. We provided in ICE and FACE appropriate vibro-acoustic environment [61-63] and analyzed passengers' perception of comfort.

In the production of mechanical systems and especially in motor vehicles, the acoustic information content in the radiated sound is subjectively often used as a "condition monitoring". Therefore, reproducible measurement procedures are useful for objectifying the auditory sensation [53-55]. Especially (variable) tonal components in predominantly broadband noise are focused in acoustic perception and have either an informative or annoying character. Technical measurement methods for "tonality" were investigated and expanded in Matthias Vormann's dissertation thesis [56].

[11] The Acoustic Group was project leader

5.3 Medical Physics and Acoustics

The physics and physiology of hearing are of great importance for the development of medical and technical aids for hearing-impaired people. On the other hand, research into the physiological causes of hearing loss provides deeper insights into neuronal signal processing. Compensating for the loss of hearing requires not only the involvement of medicine, but also the development of complex signal processing in appropriate electronic aids. Soon after 2000, the thematic breadth necessary for research into the sensory organ led to cooperation with the Hannover Medical School and the University of Hannover as well as to the establishment of the "Hearing Technology and Audiology"[12] course, including joint doctorates at the Jade University of Applied Sciences Oldenburg (Prof. Matthias Blau[13]). In 2012, Prof. Kollmeier and his Medical Physics Group, together with scientists from Biology, Psychology, Medicine and Technology, successfully acquired the Cluster of Excellence "Hearing for All"[14]. A "Department Medical Physics and Acoustics"[15] was formed 2013 in the new School of Medicine and Health Science with the previous acoustic groups. The Department was expanded by eight research sections with corresponding professorships, laboratories and research facilities. Since 2010, the research of the Acoustics Group has been continued in the "Section Acoustics" with great success by Prof. Steven van de Par, after Prof. Mellert retired in 2009.

6. ACKNOWLEDGMENTS

With the construction of the science faculty buildings of the new University of Oldenburg in 1982, the Acoustics Group was able to move into laboratories with solid basic equipment, including a large anechoic chamber and an acoustic wind tunnel. However, the university's personnel resources were and are (traditionally) very limited. It was and is therefore necessary to raise project-related research funds in order to enable students to gain professional qualifications by working in a research and development project. Without the support of the German Research Foundation DFG, the European Commission and the Federal and State Ministries, each of which is responsible for the subject, the contribution of the Acoustics Group to the subject acoustics would not have been possible. We would like to take this opportunity to thank the institutions for funding.

[12] https://www.jade-hs.de/tgm/studium/ha/
[13] https://www.jade-hs.de/team/matthias-blau/
[14] https://uol.de/exzellenzinitiative
[15] https://uol.de/en/mediphysics-acoustics

7. REFERENCES

[1] Mellert, V.: Vergleichende Beurteilung von Verkehrsgeräuschen - erste Ergebnisse und Korrelation mit physikalischen Parametern. In: Fortschritte der Akustik - DAGA '76 (Heidelberg), S. 289, Düsseldorf: VDI – Verlag 1976

[2] Wilken, W., Mellert, V.: Measurement of Fluctuating Outdoor Sound Propagation Using an Analytical Signal. In: Proc. InterNoise'81, Vol 2, pp. 981. Delft 1981. https://ince.publisher.ingentaconnect.com/contentone/ince/incecp/1981/00001981/00000002/art00014

[3] Wilken, W.: Correlation of Wind and Turbulence with Outdoor Sound Propagation. In: 11th Intern. Congr. on Acoustics, Vol.1, p. 37. Paris 1983

[4] Mellert, V., Radek, U., Wilken, W.: Correlation measurement of an acoustic transfer function with time varying phase. In: 11th Intern. Congr. on Acoustics, Vol.1, p.57. Paris 1983

[5] Wilken, W. (1980) Die Korrelationsmessung der Schallausbreitung im Freien über größere Entfernungen. DAGA '80, München.. ISBN: (3-8007-1186-9), pp. 191-194. VDE Verlag 1980.

[6] Wilken, W: Untersuchung der Schallausbreitung in der turbulenten Atmosphäre durch Korrelationsanalyse und fraktale Dimensionsanalyse. Dissertation, Universität Oldenburg 1986.

[7] Mellert, V., Schultz, M., Sill, A., Pade, H. J.: "Propagation of sound in a model atmosphere. In: 11th International Congress on Acoustics, Vol.1, p.61. Paris 1983

[8] Betke, K.: New hearing threshold measurements for pure tones under free field listening conditions. J. Acoust. Soc. Amer. 89, 2400 - 2403, (1991)

[9] Radek, U., Klug, H., Mellert, V.: Impulsive sound source of high intensity for outdoor sound propagation measurements. In: 13th International Congress on Acoustics - ICA '89, p. 23. Belgrad 1989

[10] Mellert, V., Klug, H, Radek, U.: Acoustic probing of meteorological and acoustical Parameters in outdoor sound propagation. In: 13th International Congress on Acoustics - ICA '89, p. 27. Belgrad 1989

[11] Große, R., and Li, B.: Sound propagation in random media. A new theory generalizing the parabolic equation method. Inst. Acoust. Proc., Vol, 13 Part 2, pp.373-380 (1991).

[12] Li, B., Grosse, R., Mellert, V. Sound-Propagation in Random-Media - Backscattering Correction to the Multiple Forward Scattering-Theory. Journal De Physique IV, Vol 2, No C1, pp. 557-560.(1992) https://doi.org/10.1051/jp4:19921120

[13] Mellert, V., Ostashev, V. E., Wandelt, R.: Sound scattering by scalar and vector random fields" Proc. 6th Intern. Symp. on Long Range Sound Propagation, Ottawa, pp. 343-356. (1994). https://olemiss.app.box.com/v/NCPA-LRSP-19

[14] Ostashev, V. E., B. Brahler, V. Mellert, and G. H. Goedecke. Coherence functions of plane and spherical waves in a turbulent medium with the von Karman spectrum of medium inhomogeneities. J. Acoust. Soc. Amer. 104(2), 727-737. (1998)

[15] Ostashev, V., Juvé, D. Blanc-Benon, P.: Derivation of a Wide-Angle Parabolic Equation for Sound-Waves in Inhomogeneous Moving-Media. Acustica united with acta acustica 83(3), pp. 455 – 460. (1998)

[16] Wilken, W., Wempen, J.: An FFT-Based, High-Resolution Measuring Technique with Application to Outdoor Ground Impedance at Grazing-Incidence. J. Noise Cont. Eng. 27(2): pp. 52-60. (1986)

[17] Wempen, J.: Ground Effect on Long Range Propagation of Acoustics, Inst. Acoust. Proc., Vol 9, Part 5, p 29 (1987).

[18] Wempen, J.: The Ground Wave in Outdoor Sound Propagation. Inst. Acoust. Proc. Vol 11, pp. 265 (1989).

[19] Wempen, J., Mellert, V.: Measurement of the Ground Impedance Using the Acoustic Reflection Coefficient for Plane and Spherical Waves. Acustica 72(3), pp. 197-213. (1990)

[20] Teuber, S., Mellert V.: The influence of moisture content on the acoustical properties of model materials for sand. Proc. INTER-NOISE 93, Leuven, Vol.III, pp. 1623-1626 (1993). https://ince.publisher.ingentaconnect.com/contentone/ince/incecp/1993/00001993/00000003/art00041

[21] Teuber, S., Mellert V.: Impedance of porous materials - comparison between measurements and theoretical models. Proc. 15th ICA. Bd. II, pp. 685-688. (1995)

[22] Nocke, C.: In-situ acoustic impedance measurement using a free-field transfer function method. Applied Acoustics 59(3), 253-264 (2000).

[23] Kruse, R.: Application of the two-microphone method for in-situ ground impedance measurements. Acta acustica united with acustica, 93(5), 837-842 (2007)

[24] Kruse, R., Mellert, V.: Manfred Schroeder and Acoustical Impedance. In: Xiang, N., Sessler, G. (Eds): Acoustics, Information, and Communication. Modern Acoustics and Signal Processing. pp. 229-239. Springer, Cham. 2015. https://doi.org/ 10.1007/978-3-319-05660-9_12

[25] Englich, D., Mellert, V., Radek, U., Schmidetzki, R: Measurement of meteorological parameters of the atmospheric boundary layer by tomographic sounding. Proc. Inst. Acoust. Vol 13, Part. 2, pp. 365-372, (1991)

[26] Englich, D.; Mellert, V.: Reconstruction of sound velocity profiles in the atmosphere from impulse measurements. In: J. Jones (Ed.): Acoustical Imaging Vol. 21, pp 683-690, Plenum, New York, 1994

[27] Schwarz-Röhr, B.; Mellert, V.: Acoustic determination of scale and structure constants in fluctuating fluid. In: Acoustical Imaging Vol. 23, p. 493, Plenum, N.Y. 1997

[28] Schwarz-Röhr, B., Mellert V., Acoustic sounding the statistics of fluctuating fluid. In: Acoustical Imaging Vol 23, pp. 543-555, Plenum, N.Y. 1997

[29] Mellert, V.: Schallausbreitung in der turbulenten Atmosphere - von der Immisionsprognose zur akustischen Sondierung. In: Fortschritte der Akustik - DAGA 93, S. 44-62, Bad Honnef: DPG-GmbH 1993

[30] Klug, H.: Sound - speed profiles determined from outdoor sound propagation measurements. J. Acoust. Soc. Amer. Vol. 90, pp. 475 (1991); https://doi.org/10.1121/1.401272

[31] Nocke, C., Mellert, V., Teuber, S.: Experimentelle Bestimmung beliebiger Oberflächenimpedanz mit Hilfe des Kugelwellenreflexionsfaktors. In: Fortschritte der Akustik DAGA 95, S. 623-626, Oldenburg, DEGA e.V. 1995

[32] Harms, H., Schwarz-Röhr, B., Matuschek, R., Mellert, V.: Reflection coefficient of marine sediment at grazing sound incidence. ACUSTICA/acta acustica 82, 2,Supplement, p. 259 (1996)

[33] Harms, H., Matuschek, R., Mellert, V.: Reflection coeffizient of marine sediment covered with liquid pollutants. 134th ASA meeting. Journ. Acoust. Soc. Amer. 102, p. 3210 (1997)

[34] Harms, H., Matuschek, R., Mellert, V.: Changes in Acoustic Impedance of Marine Sediment Covered with Liquid Pollutants. 16th Int. Congr. on Acoustics, Proceedings 1051-1052, and Journ. Acoust. Soc. Amer. 103, p. 2866. (1998)

[35] Mehrgart, S., Mellert, V.: Transformation Characteristics of the External Human Ear. J. Acoust. Soc. Amer. 61, pp 1567 (1977)

[36] Mellert, V.: From Manikin to microphone arrays - development and application of binaural measurement devices. 148th Meeting of the Acoustical Society of America, San Diego. J. Acoust. Soc. Amer. Vol. 116, pp. 2473. (2004)

[37] Weber, R., Mellert, V.: Vergleichende Beurteilung von Verkehrsgeräuschen - Korrelation mit Lautstärke-parametern. In: Fortschritte der Akustik – DAGA ´78. Berlin: VDI-Verlag 1978

[38] Gabriel,B., Kollmeier, B., Mellert, V.: Influence of Individual Listener, Measurement Room and Choice of Test-Tone Levels on the Shape of Equal-Loudness level contours. ACUSTICA/acta acustica 83, pp. 670-683. (1997).

[39] Dau, T., Wegner, O., Mellert, V. and Kollmeier, B. . Auditory brainstem responses (ABR) with optimized chirp signals compensating spatial basilar membrane dispersion. J. Acoust. Soc. Amer. 107: pp. 1530-1540. (1998).

[40] Sato, S., Ando, Y. and Mellert, V.: Cues for localization in the median plane as extracted from the auto-correlation function. Journal of Sound and Vibration 241(1), pp. 53-56.(2001)

[41] Bellmann, M.A., Mellert, V., Reckhardt, C. Remmers, H.: Sound and Vibration at low frequencies,. In: Physiology and Models, T. Dau. V. Hohmann, B. Kollmeier (Eds), World Scientific, pp. 117-120, 1999. https://doi.org/10.1142/9789812818140_0025

[42] Daniel P., Weber R.: Calculating psychoacoustical roughness. In: Contributions to Psychological Acoustics: Results of the Sixth Oldenburg Symposion on Psychological Acoustics. Ed. Schick A., pp. 251 BIS Universität. Oldenburg 1993.

[43] Weber, R.: Psychoacoustical parameters contributing to the unpleasantness of noise. In: Müller, F. (Eds.): Proc. of the Sixth Annual Meeting of the Intern. Soc. for Psychophysics. Würzburg 1990, F.R.G. Fechner Day 1990: pp. 193-198.

[44] Buss, S., Weber R.: Subjective and objective characterization of tonal components in tyre/ road noise. CFA/ DAGA '04, Strassburg, Frankreich, 2004. pp. 495/496. Société Francaise d'Acoustique Deutsche Gesellschaft für Akustik e.V (2004).

[45] Mellert, V., Weber R., Nocke, C.: Assessment of impact of acoustic and non-acoustic parameters on performance and well-being, J. Acoust. Soc. Amer. 115, pp. 2369. (2004)

[46] Weber, R., Baumann I., Freese N., Kruse R., Mellert, V.: Psychoacustic analysis of sound in the cabin of passenger aircrafts Euronoise 2003, Neapel, (2003). ISBN: (88-88942-00-9), pp. 1-6; paper ID: 457-IP. http://www.akustik.uni-oldenburg.de/literatur/Mellert/EURONOISE2003_SS01-457-IP.pdf

[47] Bellmann, M., Remmers, H.: Evaluation of vibration perception in passenger vehicles and aircrafts. Euronoise 2003, Neapel, Italien, (2003). ISBN: (88-88942-00-9), pp. 1-6; paper ID: 489-IP. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=cd9c2075547b2c462f8ec4a0ac36abfb83cc7474.

[48] Mellert, V., I. Baumann, N. Freese, Weber, R.: Impact of sound and vibration on work load of cabin and flight crew. Forum Acusticum, Budapest, 2005. ISBN: (963-8241-68-3), pp. L37-L40..

[49] Mellert, V., Baumann, I., Freese, N., Kruse, R., Weber, R.: Impact of Workplace Environment on Health and Comfort of Flight Attendants and Pilots – Results from the EU-Projekt HEACE. In: 25th Intern. Congr. of the Aeronautical Science. ICAS 2006. http://icas.org/ICAS_ARCHIVE/ICAS2006/PAPERS/366.PDF

[50] Mellert, V., Baumann, I., Freese, N., Weber, R.: Impact of sound and vibration on health, travel comfort and performance of flight attendants and pilots. Aerospace Science and Technology. Vol. 12, pp. 18–25. (2008). https://doi.org/10.1016/j.ast.2007.10.009

[51] Baumann, I., Trimmel, M.: Distribution of subjective assessments in a controlled aircraft environment. Aerospace Sci. and Tech. 25(1), pp. 23-101. (2013). https://doi.org/10.1016/j.ast.2011.12.012

[52] Bellmann, M. Perception of Whole-Body Vibrations: From basic experiments to effects of seat and steering-wheel vibrations on the passenger's comfort inside vehicles. ISBN: (3-8322-0857-7) 209 pages. Shaker Verlag, Aachen 2002.

[53] Remmers, H., Betke, K., Wempen, J., Mellert, V.: Machinery noise diagnostics by ear-related parameters. In: Proc. InterNoise ‘89, p. 1161. (1989) https://ince.publisher.ingentaconnect.com/contentone/ince/incecp/1989/00001989/00000001/art00029

[54] Mellert, V; Betke, K;: Monitoring machinery noise by pattern recognition with psychoacoustic parameters. (invited contribution in memoriam E. Zwicker). Proc. Inter-noise '91, p. 57-60. AAS, Sydney (1991) https://ince.publisher.ingentaconnect.com/contentone/ince/incecp/1991/00001991/00000005/art00009

[55] Hansen, H., R. Weber, R., Letens, U.: Quantifying tonal phenomena in interior car sounds. Proc. Forum Acusticum, Budapest, 2005. ISBN: (963-8241-68-3), pp. 1725-1729.

[56] Vormann, M.: Untersuchungen zu psychoakustischen Mess- und Berechnungsverfahren der Tonhaltigkeit. Oldenburg 2011. http://oops.uni-oldenburg.de/1339/

[57] https://cordis.europa.eu/project/id/BRPR970476

[58] Thesis of J. Quehl, https://oops.uni-oldenburg.de/340/

[59] Friendcopter: EC project AIP3-CT-2003-502773

[60] Quaranta, V., Dimino, I., d'Ischia M.,, Cenedese,F.: 3D internal noise simulation for vibro-acoustic comfort assessment: An application proposal for AW-109 helicopter. Aerotecnica 90(4), pp. 119-130. (2011)

[61] NLR Report (2012): https://reports.nlr.nl/server/api/core/bitstreams/ec9b5a5d-d008-44ae-a1c2-5119aad316c3/content

[62] Grün, G., Holm, A.H., Luks, N., Malone-Lee, J., Trimmel, M., Schreiber, R., Mellert, V., Kos, J., Hofbauer, W.: Impact of Cabin Pressure on Aspects of the Well-Being of Aircraft Passengers – a Lab. Study. 26th Intern. Congr. Aeron. Science. ICAS2008. https://www.icas.org/ICAS_ARCHIVE/ICAS2008/PAPERS/402.PDF

[63] FACE: https://cordis.europa.eu/project/id/G4RD-CT-2002-00764