

Sound transmission in a simple model of the ear canal and tympanic membrane

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Abstract – The classic picture of middle ear (ME) transmission has the tympanic membrane (TM) as a piston and the ME space as a vacuum. However, the TM moves in a complex wavy pattern and modern theories link this behavior to the MEs broadband transmission (e.g. Fay et al, PNAS 2006, Parent and Allen, JASA 2007). Furthermore, Rabbitt (JASA 1990) predicted that the TM radiated considerable sound pressure into the ME space that could in return affect TM motion. This study explores these ideas with a simple model, using a tube terminated with a plastic membrane to model the EC and TM. We measured membrane motion via laser interferometry, and pressure (on both sides) via micro-sensors that allowed positioning very close to the membrane (10 micrometers) without disturbance. We made a finite element model of the system to complement the experimental results. The theoretical results show the interaction of acoustic and mechanical resonances, and both theoretical and experimental results show strong transmission of sound through the membrane at some of its resonant frequencies.

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