



Dáibhid Ó Maoiléidigh, PhD

Assistant Professor of Otolaryngology - Head & Neck Surgery (OHNS)
Otolaryngology (Head and Neck Surgery)

Bio

BIO

Dr. Ó Maoiléidigh received his BA in Theoretical Physics and MSc in High-Performance Computing from Trinity College Dublin through a full scholarship from the Irish Government. He then received his PhD in Physics from Rutgers University, where he studied pausing in transcription elongation using mathematical and computational approaches. Dr. Ó Maoiléidigh first began to work in the field of hearing research as a Guest Scientist at the Max Planck Institute for the Physics of Complex Systems. He described how the cochlear amplifier arises from a combination of two forms of active motility in the mammalian cochlea. As a Postdoctoral Associate and Research Associate in The Rockefeller University, he developed models of cochlear mechanics, hair-bundle motility, and synaptic dynamics. A model of hair-bundle motility explained mechanistically how it is possible for hair bundles to have a different function in hearing organs in comparison to balance organs. Under Dr. Ó Maoiléidigh's guidance, several predictions of this model were verified experimentally using a novel experimental system.

Dr. Ó Maoiléidigh founded the annual Sense to Synapse conference in 2012. This meeting brings researchers together who use experimental or computational methods to study any aspect of sensory perception (<http://www.sense2synapse.com/>).

Dáibhid Ó Maoiléidigh's laboratory is part of the Research Division in the Department of Otolaryngology-Head and Neck Surgery. His laboratory uses mathematical and computational approaches to study hearing and balance disorders. Recently, the Ó Maoiléidigh lab explained how the 3D structure of a hair bundle controls its function, how intrinsic noise limits the threshold of hearing, and how receptor-current adaptation in hair cells is critical for cochlear amplification.

ACADEMIC APPOINTMENTS

- Assistant Professor, Otolaryngology (Head and Neck Surgery)
- Member, Bio-X
- Member, Wu Tsai Human Performance Alliance
- Member, Maternal & Child Health Research Institute (MCHR)
- Member, Wu Tsai Neurosciences Institute

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Associate Editor, Journal of the Association for Research in Otolaryngology (2022 - present)
- Academic Editor, PLOS ONE (2019 - present)
- Member, Society for Neuroscience (2020 - present)

- Member, Association for Research in Otolaryngology (2012 - present)
- Member, Biophysical Society (2011 - present)
- Member, American Physical Society (2008 - present)

PROFESSIONAL EDUCATION

- PhD, Rutgers, the State University of New Jersey , Physics (2006)
- MSc, Trinity College Dublin , High-Performance Computing (2000)
- BA, Trinity College Dublin , Theoretical Physics (1999)

LINKS

- Lab: <https://melodylab.stanford.edu>
- Google Scholar: <https://scholar.google.com/citations?user=oCfwcU4AAAAJ>

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

The Ó Maoiléidigh group employs mathematical and computational approaches to better understand normal hearing and hearing impairment. Because complete restoration of auditory function by artificial devices or regenerative treatments will only be possible when experiments and computational modeling align, we work closely with experimental laboratories. Our goal is to understand contemporary experimental observations, to make experimentally testable predictions, and to motivate new experiments. We are pursuing several projects.

Hair-Bundle Mechanics

Auditory and balance organs rely on hair cells to convert mechanical vibrations into electrical signals for transmission to the brain. In response to the quietest sounds we can hear, the hair cell's mechanical sensor, the hair bundle, moves by less than one-billionth of a meter. To determine how this astounding sensitivity is possible, we construct computational models of hair-bundle mechanics. By comparing models with experimental observations, we are learning how a hair bundle's geometry, material properties, and ability to move spontaneously determine its function.

Cochlear Mechanics

The cochlea contains the auditory organ that houses the sensory hair cells in mammals. Vibrations in the cochlea arising from sound are amplified more than a thousandfold by the ear's active process. New experimental techniques have additionally revealed that the cochlea vibrates in a complex manner in response to sound. We use computational models to interpret these observations and to make hypotheses about how the cochlea works.

Teaching

COURSES

2025-26

- Biology and Physics of Hearing: OTOHNS 204 (Spr)

2024-25

- Biology and Physics of Hearing: OTOHNS 204 (Spr)

2023-24

- Biology and Physics of Hearing: OTOHNS 204 (Spr)

2022-23

- Biology and Physics of Hearing: OTOHNS 204 (Spr)

STANFORD ADVISEES

Postdoctoral Faculty Sponsor

Varun Goyal, Joey Marcinik, Riccardo Marrocchio

Publications

PUBLICATIONS

- **Viscoelasticity explains fast adaptation in the auditory amplifiers of mammals.** *Biophysical journal*
Chatterjee, R., Maoiléidigh, D. Ó.
2025
- **Stereocilium height changes can account for the calcium dependence of the outer-hair-cell bundle's resting state.** *PLoS one*
Chatterjee, R., Ó Maoiléidigh, D.
2025; 20 (5): e0314728
- **Links regulate deflection fluctuations in the sensory cells of hearing** *Physical Review E*
Marrocchio, R., Ó Maoiléidigh, D.
2025; 111: 034403
- **Gating-spring stiffness increases outer-hair-cell bundle stiffness, damping, and receptor current.** *Scientific reports*
Zhu, Z., Reid, W., Ó Maoiléidigh, D.
2024; 14 (1): 29904
- **3D Morphology of an Outer-Hair-Cell Hair Bundle Increases Its Displacement and Dynamic Range.** *Biophysical journal*
Zhu, Z., Reid, W., George, S. S., Ou, V., Maoiléidigh, D. Ó.
2024
- **The coherency of motion of two stereocilia depends on the viscoelastic properties of their link** *15th International Mechanics of Hearing Workshop*
Marrocchio, R., Ó Maoiléidigh, D.
Zenodo.2024
- **The 3D Morphology of the Outer-Hair-Cell Hair Bundle Causes Spatial Variation in Its Stereocilium Displacements and Channel Currents** *15th International Mechanics of Hearing Workshop*
Zhu, Z., Ó Maoiléidigh, D.
Zenodo.2024
- **Resting Calcium Dependence of the Outer Hair Cell Hair Bundle** *15th International Mechanics of Hearing Workshop*
Chatterjee, R., Ó Maoiléidigh, D.
Zenodo.2024
- **The Functional Contributions of Links in Mammalian Cochlear Hair Bundles** *14th International Mechanics of Hearing Workshop*
Zhu, Z., Reid, W., Ó Maoiléidigh, D.
2024: 050008
- **Coupling between the stereocilia of rat sensory inner-hair-cell hair bundles is weak, shaping their sensitivity to stimulation.** *The Journal of neuroscience : the official journal of the Society for Neuroscience*
Scharr, A. L., Maoileidigh, D. O., Ricci, A. J.
2023
- **Dimensions of a Living Cochlear Hair Bundle** *Front Cell Dev Biol*
Miller, K. K., Atkinson, P., Mendoza, K., Ó Maoiléidigh, D., Grillet, N.
2021; 9: 742529

- **A Bundle of Mechanisms: Inner-Ear Hair-Cell Mechanotransduction** *Trends in neurosciences*
Ó Maoiléidigh, D., Ricci, A. J.
2019; 42: 221-236
- **Bilateral spontaneous otoacoustic emissions show coupling between active oscillators in the two ears** *Biophysical Journal*
Roongthumskul, Y., Ó Maoiléidigh, D., Hudspeth, A.
2019; 116: 2023-2034
- **Multiple mechanisms for stochastic resonance are inherent to sinusoidally driven noisy Hopf oscillators.** *Physical Review E*
O Maoileidigh, D.
2018; 97: 022226
- **Sinusoidal-signal detection by active, noisy oscillators on the brink of self-oscillation** *Physica D*
Ó Maoiléidigh, D., Hudspeth, A. J.
2018; 378-379: 33-45
- **Homeostatic enhancement of sensory transduction.** *Proceedings of the National Academy of Sciences of the United States of America*
Milewski, A. R., Ó Maoiléidigh, D., Salvi, J. D., Hudspeth, A. J.
2017; 114 (33): E6794-E6803
- **Mechanical Transduction Processes in the Hair Cell** *Understanding the Cochlea*
David, C. P., Ó Maoiléidigh, D., Ashmore, J. F.
Springer International Publishing.2017: 75–111
- **Identification of Bifurcations from Observations of Noisy Biological Oscillators.** *Biophysical journal*
Salvi, J. D., Ó Maoiléidigh, D., Hudspeth, A. J.
2016; 111 (4): 798-812
- **Control of a hair bundle's mechanosensory function by its mechanical load.** *Proceedings of the National Academy of Sciences of the United States of America*
Salvi, J. D., Ó Maoiléidigh, D., Fabella, B. A., Tobin, M., Hudspeth, A. J.
2015; 112 (9): E1000-9
- **Vibrational Modes and Damping in the Cochlear Partition** *MECHANICS OF HEARING: PROTEIN TO PERCEPTION*
Maoileidigh, D. O., Hudspeth, A. J.
2015; 1703
- **Middle Ear Mechanics and Progress in Cochlear Modeling: A Moderated Discussion** *MECHANICS OF HEARING: PROTEIN TO PERCEPTION*
Allen, J. B., Nakajima, H. H., Maoileidigh, D. O.
2015; 1703
- **Characterization of Active Hair-Bundle Motility by a Mechanical-Load Clamp** *MECHANICS OF HEARING: PROTEIN TO PERCEPTION*
Salvi, J. D., Maoileidigh, D. O., Fabella, B. A., Tobin, M., Hudspeth, A. J.
2015; 1703
- **Effects of cochlear loading on the motility of active outer hair cells.** *Proceedings of the National Academy of Sciences of the United States of America*
Ó Maoiléidigh, D., Hudspeth, A. J.
2013; 110 (14): 5474-5479
- **Comparison of nonlinear mammalian cochlear-partition models.** *journal of the Acoustical Society of America*
Szalai, R., Champneys, A., Homer, M., Ó Maoiléidigh, D., Kennedy, H., Cooper, N.
2013; 133 (1): 323-336
- **Frequency-Selective Exocytosis by Ribbon Synapses of Hair Cells in the Bullfrog's Amphibian Papilla** *JOURNAL OF NEUROSCIENCE*
Patel, S. H., Salvi, J. D., Maoileidigh, D. O., Hudspeth, A. J.
2012; 32 (39): 13433-13438
- **The diverse effects of mechanical loading on active hair bundles.** *Proceedings of the National Academy of Sciences of the United States of America*

- Ó Maoiléidigh, D., Nicola, E. M., Hudspeth, A. J.
2012; 109 (6): 1943-1948
- **Divalent counterions tether membrane-bound carbohydrates to promote the cohesion of auditory hair bundles.** *Biophysical journal*
Leboeuf, A. C., Ó Maoiléidigh, D., Hudspeth, A. J.
2011; 101 (6): 1316-1325
 - **A Unified Model of Transcription Elongation: What Have We Learned from Single-Molecule Experiments?** *BIOPHYSICAL JOURNAL*
Maoileidigh, D. O., Tadigotla, V. R., Nudler, E., Ruckenstein, A. E.
2011; 100 (5): 1157-1166
 - **High-Frequency Power Gain in the Mammalian Cochlea** *WHAT FIRE IS IN MINE EARS: PROGRESS IN AUDITORY BIOMECHANICS*
Maoileidigh, D. O., Hudspeth, A. J.
2011; 1403
 - **The interplay between active hair bundle motility and electromotility in the cochlea.** *journal of the Acoustical Society of America*
O Maoiléidigh, D., Jülicher, F.
2010; 128 (3): 1175-1190
 - **THE INTERPLAY BETWEEN ACTIVE HAIR BUNDLE MECHANICS AND ELECTROMOTILITY IN THE COCHLEA** *CONCEPTS AND CHALLENGES IN THE BIOPHYSICS OF HEARING*
Maoileidigh, D., Juelicher, F.
2009: 451-456
 - **Thermodynamic and kinetic modeling of transcriptional pausing** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Tadigotla, V. R., O'Maoileidigh, D., Sengupta, A. M., Epshtein, V., Ebright, R. H., Nudler, E., Ruckenstein, A. E.
2006; 103 (12): 4439-4444
 - **Signal detection by active, noisy hair bundles** *13th Mechanics of Hearing Workshop*
Ó Maoiléidigh, D., Salvi, J. D., Hudspeth, A. J.
: 060002
 - **Homeostatic enhancement of active mechanotransduction** *13th Mechanics of Hearing Workshop*
Milewski, A., Ó Maoiléidigh, D., Hudspeth, A. J.
: 120007