

The Civil and Environmental Engineering and
Mechanical Engineering Departments

The Jan D. Achenbach Lecture

Illustrations of entropic force as induced
through random fluctuations of elastic
bio-membranes

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Urbana -Champaign

May 14, 2013
2:00 p.m.
Technological
Institute, L211



When immersed in water at room temperature, a deformable membrane tends to undergo random fluctuations in shape driven by the brownian motion of water molecules. The membrane shapes that arise in the course of such fluctuations can be influenced significantly by external factors. For example, motions can be restricted as a result of molecular bonding of certain material points on the membrane to external objects; similarly, fluctuation amplitudes can be limited as a result of the proximity to other surfaces. Such restrictions give rise to entropic forces, a type of force which develops solely as a result of the tendency of any material system to increase its entropy. The notion of entropic force will be introduced by means of a relatively simple example drawn from the literature on measurement of very small forces in biological systems. This will be followed by descriptions of recent results on the competition between molecular bonding and membrane fluctuations and on the dependence of the pressure required to restrict overall fluctuations of a membrane on the degree of restriction. The latter will include a recent result which is at variance with the prevailing literature on this subject.

L. B. Freund is Adjunct Professor of Materials Science and Engineering at the University of Illinois at Urbana-Champaign and the H. L. Goddard University Professor Emeritus at Brown University. He received his PhD degree from Northwestern University in 1967 and was a member of the Engineering faculty at Brown University from then until his retirement in 2010. He is the author or co-author of published articles on stress waves in solids, fracture mechanics, seismology, computational mechanics, dislocation theory, mechanics of thin films, microstructure evolution in materials, bio-adhesion, statistical mechanics and engineering education, plus monographs on Dynamic Fracture Mechanics (Cambridge University Press 1990) and, jointly with S. Suresh, on Thin Film Materials (Cambridge University Press 2003, Science Press (in Chinese) 2006). He is a member of the National Academy of Sciences, the National Academy of Engineering, and the American Academy of Arts and Sciences.



Jan D. Achenbach

Born in the Netherlands, Achenbach became a member of Northwestern's faculty in 1963. Since then, he has become highly respected for his work in the areas of wave propagation in solids and for pioneering the field of quantitative non-destructive evaluation.

The Jan D. Achenbach Lecture recognizes Achenbach for his extraordinary contributions to the field of mechanics, as well as his profound impact on McCormick's departments of Mechanical Engineering, Civil and Environmental Engineering, and Engineering Sciences and Applied Mathematics.

Achenbach received a National Medal of Technology in 2003 for his contributions to engineering research and education and for pioneering methods for detecting dangerous cracks and corrosion in aircraft, advances that have led to improved air safety. He was also awarded a 2005 National Medal of Science, the nation's highest honor for innovation in technology and science.

He was elected a member of the National Academy of Engineering in 1982, a member of the National Academy of Sciences in 1992, and a fellow of the American Academy of Arts and Sciences in 1994. In 1999, he was elected a corresponding member of the Royal Dutch Academy of Sciences, and in 2009, he was elected a fellow of the World Class Universities Program of the National Research Foundation of Korea. He is also an honorary member of the American Society of Mechanical Engineers and a fellow of ASME, ASA, SES, AMA, and AAAS. His awards include the 2012 ASME Medal, the Timoshenko Medal, the William Prager Medal, and the Theodore von Karman Medal. In 2011, he was awarded a rare honorary doctorate degree from China's Zhejiang University.

Achenbach is founder of Northwestern's Center for Quality Engineering and Failure Prevention, a state-of-the-art laboratory for quality control in structural mechanics.

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