

ECHOES

Volume 23, Number 1
Winter 2013

Vibration of thick bilaminar finite plates: 3-D elasticity model

Sabih I. Hayek and Jeffrey E. Boisvert

The vibration and acoustic radiation from excited elastic plates in contact with one or two fluid media has been researched by numerous authors over the last seven decades and is a fundamental canonical problem in the field of structural acoustics. Its relevance spans a broad range of practical applications in numerous technical fields. The elastic plate theory employed in most of these studies is due to Kirchhoff classical theory of plate bending. The validity of these studies is limited to relatively low frequency acoustic radiation from relatively *thin* plates due to the approximate theory. A more refined theory incorporating shear deformation and rotatory inertia extended the theory to a higher frequency regime, and applies to relatively *thicker* plates.

The literature on vibration and radiation from elastic plates, valid for even higher frequencies and/or thicker plates, is considerably sparse when the theory of motion is based on the *exact* theory of elasticity. The use of the exact theory implies that the results are valid over *all* frequencies for plates of *any* thickness. Various authors have investigated the response of single and multi-layered *infinite* plates using the exact theory under point and line force excitation. Infinite here implies the plate has lateral dimensions that extend indefinitely. For the case of the exact theory of *finite* elastic plates, a paper by Berry *et al.* considered the vibration and radiation from a bilaminar plate set in a rigid baffle. The bilaminar rectangular plate consisted of a decoupler plate modeled with 3-D elasticity theory bonded to an elastic base plate modeled with *classical* plate theory.

In this article, a *finite* rectangular bilaminar plate is fully modeled using the exact three-dimensional equations of elasticity. The bilaminar plate is comprised of two perfectly bonded elastic plates, each having the same lateral dimensions, but different thicknesses and material properties. It is set in an infinite rigid baffle and is in contact with a different fluid medium on each of its faces, as depicted in Figure 1. The plate is free of

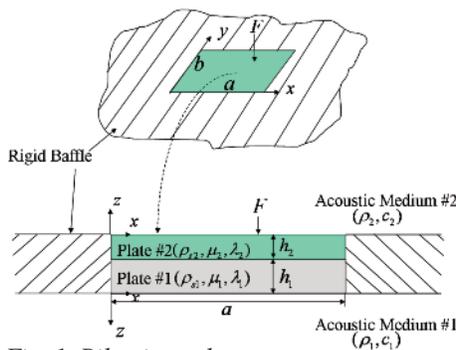


Fig. 1. Bilaminar plate geometry

shear stresses and has vanishing in-plane displacements on all its boundaries. This means that the entire bilaminar plate is free to move in the normal direction in response to surface forces. The two plates are perfectly bonded so that total continuity of stresses and displacements is enforced at their bonded interface. Continuity of acoustic normal velocities and pressures to plate surface velocities and stresses are also enforced.

First, to examine the role of thickness on plate response, numerical results were obtained for a submerged rectangular bilaminar plate of aspect ratio $b/a=2$, and comprised of two identical steel plates resulting in a monolithic plate. Two values of the thickness ratio were selected, $h/a=0.01, 0.2$, corresponding to a very thin and thick plate, respectively. Here h is the total thickness ($h=h_1+h_2$), and a is the lateral dimension of the plate along the x -axis. The damping factor used for steel is $\eta=0.001$. A driving point force is applied on the top surface of the bilaminar plate at the centerpoint ($a/2, b/2$). To investigate the behavior of the finite plate as modeled by elasticity theory, the normal displacement at the top, middle, and bottom surfaces were computed at the centerpoint of the plate, over the non-dimensional frequency range $\Omega=0-10$. Here $\Omega=\omega a/c_p$ and c_p is the plate velocity. For a very thin ($h/a=0.01$) steel plate with water on both surfaces, Fig. 2a shows the three displacements are identical, meaning that the assumption of constant displacement through the thickness in the classical theory is sufficiently accurate for thin plates. In contrast, the same numerical results for a very thick plate, $h/a=0.2$ in Fig 2b, shows a 25 dB higher mean-displacement for the top (the excited surface) vs. the bottom surface. This behavior proves that for thick plates, one must use exact theory for dynamic response.

Now to examine the behavior of a bilaminar plate made of steel and an elastomer, results were obtained for a bilaminar

continued on page 3

We hear that . . .

• **C. Daniel Mote** engineering professor at the University of Maryland and an ASA Fellow, has been nominated as the next president of the National Academy of Engineering. If elected by the academy's membership, Mote will succeed current president Charles Vest when Vest's term ends on 30 June 2013.

• **George Maling and William Lang** were elected Honorary Members of the National Council of Acoustical Consultants for significant contributions to the acoustical consulting profession. Only 24 individuals have been thus honored in the 50-year history of NCAC.

• **Gerhard Sessler** received the IEEE/RSE Wolfson James Clerk Maxwell Award for "pioneering contributions to electroacoustic transducers, the development of silicon microphone technology, and seminal work on electroactive materials.

• **G. Clifford Carter** received the IEEE Jack S. Kilby Signal Processing Medal for "contributions to the fundamentals of coherence and time-delay estimation and to underwater acoustics signal processing.

• **Michael Moldover** was awarded the ASME Yeram S. Touloukian Award for contributions to the equilibrium and transport areas of the thermophysical properties field.

• AAPT will hold a special session on **History and Practice in Musical Acoustics** at its meeting in New Orleans January 5-9. Invited speakers will include Thom Moore, Andy Morrison, and Brian Holmes.

• The Centre for Nanoscience and Quantum Information at the University of Bristol in the UK claims to have the "world's quietist building," according to a Nov. 8 online posting of *Physics World*. The four-story building has a number of "quiet rooms" in the basement, where most of the experiments are housed. Each experiment then sits on an additional 24-tonne block of concrete separated from the floor by rubber bearings.



Student icebreaker

From The Student Council

Jennie Wylie

Hello from Kansas City! The Kansas City meeting was a great meeting for students with 90 students attending Monday night's student icebreaker, and well over 100 students attending Wednesday night's student reception. In addition, the Student Council hosted the 2nd annual special session entitled "Introduction to technical committee research and activities: Especially for students and first-time meeting attendees." The session was a great success with a packed room. The Student Council would like to thank all of the presenters who volunteered their time and expertise to make this session possible.

Students if you would like to get involved with the Society, several positions for technical committee representatives to the Student Council are opening up, with a term to begin immediately following the Montreal meeting. Also, nominations for the next ASA Student Mentoring Award, to be presented at the Fall 2013 San Francisco meeting, are due in early spring 2013. More details on both the Student Council openings and the Mentoring Award can be found on the ASA Student Zone website at www.acosoc.org/student.

Looking towards Montreal, all students are encouraged to attend the student events and to join us for the student outings. It's a great way to meet your fellow students and learn about the exciting research they are doing. For all up to date news, especially during the meetings, subscribe to our twitter feed @ASASTudents.

Looking forward to seeing everyone in Montreal!



Jennie Wylie is a PhD student at the University of Miami and the current Underwater Acoustics representative to the Student Council. She can be contacted at j.wylie@miami.edu



Newsletter of the Acoustical Society of America

Provided as a benefit of membership to ASA members

The Acoustical Society of America was organized in 1929 to increase and diffuse the knowledge of acoustics and to promote its practical applications.

Echoes Editor Thomas Rossing
ASA Editor-in-Chief Allan Pierce
Advisors Elaine Moran, Charles Schmid

Phone inquiries: 516-576-2360. Contributions, including Letters to the Editor, should be sent to Thomas Rossing, Stanford University, CCRMA Department of Music, Stanford, CA 94305 <rossing@ccrma.stanford.edu>

ASA meets in Kansas City

continued from page 1

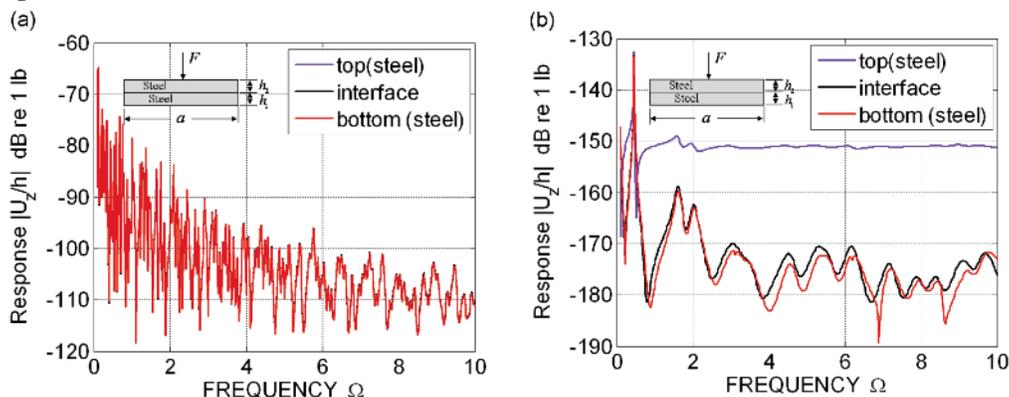


Fig. 2. Displacement response of a submerged monolithic steel plate, (a) $h/a=0.01$, (b) $h/a=0.2$

plate with the elastomer thickness being three times the thickness of the steel, such that the total thickness ratio is 0.2. The elastomer density and Young's modulus are specified as 14% and 1.2% of the corresponding values for steel, and the damping factor is $\eta=0.3$. Plate displacements when driven on the steel side are shown in Fig.3a, showing that the steel surface is displaced as much as 30 dB higher than the elastomer surface, indicating that the steel plate is solely carrying the load by itself. When the plate is driven on the elastomer side, shown in Fig.3b, the softer elastomer surface is displaced by as much as 60 dB more than the steel side, indicating that the response is totally

confined to the elastomer. The acoustic radiation spectra and directivities in the two acoustic media were also computed for the above plates, but are not shown here for brevity.

In summary, an analytical model of a finite, bilaminar rectangular plate using the three-dimensional equations of elasticity has been developed, and sample results have illustrated the role of plate thickness and material properties on the in-fluid vibration response under mechanical force excitation. The analysis can readily be extended to an n-layered system and also to consider acoustic scattering from multi-layered plates of arbitrary thickness.

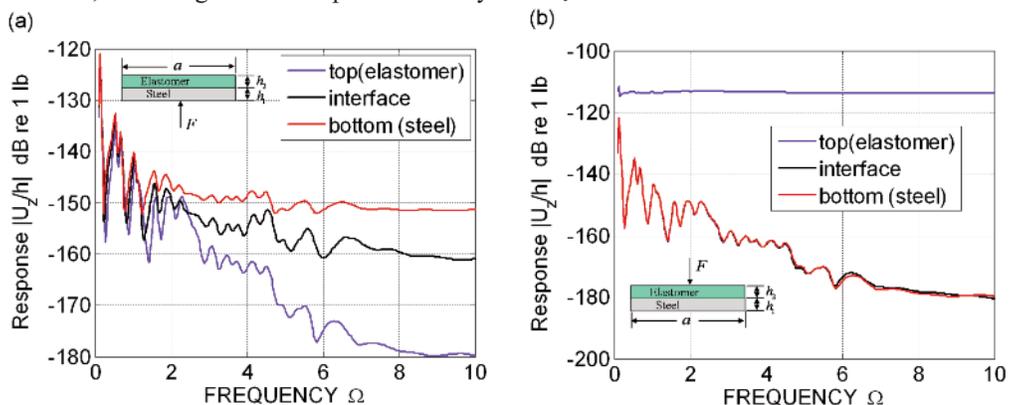


Fig. 3. Displacement response of a submerged bilaminar steel-elastomer plate with $h_1/a=0.05$ and $h_2/a=0.15$, (a) excitation on steel surface, (b) excitation on elastomer surface

This article is based on paper 4aEA1 at the 164th ASA meeting in Kansas City.

References

- Leissa, A., *Vibration of Plates* (Acoust. Soc. Amer., New York, 1993).
 Graf, K. F., *Wave Motion in Elastic Solids* (Ohio St. Univ. Press, Columbus, OH, 1975).
 Ewing, W. M., Jardetsky, W. S., and Press, F., *Elastic Waves in Layered Media* (McGraw-Hill, New York, 1957).
 Berry, A., Foin, O., and Szabo, J. P., "Three-dimensional elasticity model for a decoupling coating immersed in a heavy fluid," *J. Acoust. Soc. Am.* **109**, 2704-2714, 2001.

Sabih I. Hayek is Distinguished Professor Emeritus of Engineering Mechanics, Dept. of Eng. Science and Mechanics, Penn State University, University Park, PA. He is a Fellow of ASA and ASME, and recipient of the Trent-Crede Silver Medal. He is a member of the Technical Committee on Structural Acoustics and Vibration.



Jeffrey E. Boisvert is a research engineer at NAVSEA Division Newport in Newport, RI. He is an ASA Fellow and a member of the Technical Committee on Structural Acoustics and Vibration.

Echoes from Kansas City

Special session on a 9000 mile stage



Speakers at session 4pMU honoring Neville Fletcher. Roderick Suthers, Joe Wolfe, Judit Angster, Tom Rossing, Bill Strong, Jim Cottingham. Neville looks on from Australia. (Photo by C. Schmid)

Plans for a special session honoring the many contributions to acoustics by Neville Fletcher were well along when it was realized that Neville's health would not allow him to travel to Kansas City. Ten speakers, invited by organizers Tom Rossing and Joe Wolfe on behalf of the Musical Acoustics and Animal Bioacoustics technical committees, agreed to present their papers by means of Google Hangout. Andy Morrison and Joe Wolfe spearheaded a team that made arrangements which included a trial run to test the link.

Six speakers assembled in Kansas City, and four in

Australia for session 4pMU, in what is believed to be a first for ASA. Duplicate copies of PowerPoints, videos, and audio clips had been assembled at both sites in case of network failure, but the session proceeded without major problems. Two-way links permitted discussion and questions after each paper. The arrangement saved thousands of dollars in travel, and a substantial reduction in carbon footprint.

After the session, the Kansas City speakers and attendees retired to the buffet social, while the Australian participants enjoyed breakfast at the home of Joe Wolfe.

Best Paper Awards for Students and Young Professionals (Kansas City)

Acoustical Oceanography

Wu-Jung Lee, Woods Hole Oceanographic Institution

Animal Bioacoustics

Jilian Vitacco, University of California, Santa Cruz

Architectural Acoustics

First: Johannes Klein, RWTH Aachen University

Second: Daniel Marquez, Brigham Young University

Biomedical Acoustics

First: Kirthi Radhakrishnan, University of Cincinnati

Second: Kun Jia, Zhejiang University

Third: Karia Mercado, University of Rochester

Engineering Acoustics

First: Robert C. Randall, Advanced Technology and Manufacturing Center

Second: David A. Hague, University of Massachusetts-Dartmouth

Musical Acoustics

First: Rohan Krishnamurthy, Eastman School of Music

Second: Mert Bay, University of Illinois at Urbana-Champaign

Noise

Carl Hart, University of Nebraska-Lincoln

Signal Processing in Acoustics

Samuel J. Anderson, Pennsylvania State University

Speech Communication

First: Elizabeth Casserly, Indiana University

Second: Ben Parrell, University of Southern California

Structural Acoustics and Vibration

First: Alan T. Wall, Brigham Young University

Second: Rico Meier, Fraunhofer CSP

Underwater Acoustics

Sean Walstad, University of California, San Diego

Echoes from Kansas City



Participants in ASA School 2012 are shown in the Hotel Phillips with co-chairs Judy Dubno and Brigitte Schulte-Fortkamp (center of front row). ASA School 2012: Living in the Acoustic Environment, which preceded the ASA meeting, included two days of lectures and discussion on various topics in acoustics (photo by C. Schmid).



Michael Vorländer joins ASA jam session

ASA President David L. Bradley; New Fellows David A. Eddins, John A. Hildebrand, Andrew J. Hull, Yang-Hann Kim, William J. Murphy, Scott D. Pfeiffer, John R. Preston, and Ronald C. Scherer; ASA Vice President Michael R. Stinson



Scanning the journals

Thomas D. Rossing

- **“Accounting for Listening Levels in the Prediction of Reverberance Using Early Decay Time”** is the title of a paper in the August issue of *Acoustics Australia*. Reverberance is conventionally estimated using early decay time (similar to reverberation time), but the authors show that reverberance is better estimated using loudness decay parameters. One reason is that the loudness decay rate depends on listening level, and this dependency corresponds to subjective experimental data on loudness. The paper proposes a simplified approach to reverberance estimation using listening level to modify early decay time or reverberation time values.

- **Fluorescence imaging**, which combines light and sound, allows researchers a new technique for seeing inside the body, according to a paper in *Nature Photonics* **6**, 657 (2012). Tissue at the focus of an ultrasound wave is vibrated very vigorously by the sound waves. When visible light is scattered by the tissue at the focus, its frequency is increased or decreased by the frequency of the sound wave. In effect, the light that makes it to the tissue of interest is labeled. After separating out and measuring the wavefront of the light that was scattered by the target of the sound wave, researchers can imprint the reverse of that wavefront on a light beam traveling in the opposite direction. This light wave focuses at the same point that is the focus of the ultrasound wave. The spatial resolution is about 40µm, which is basically given by the properties of the ultrasound pulse.

- The 14 September issue of *Science* has an article about ASA Fellow **Arthur Popper and his study of fish hearing**. Popper, who is co-editor of the Springer *Handbook of Auditory Research*, has studied the effect of loud sounds on fish. He has used scanning electron microscopy to study the inner ear of fishes, showing that fish can actually regenerate damaged hair cells. He found that physiological effects experienced by the fish depend on the sound intensity and accumulated exposure. Fish exposed to high-intensity sound could experience lethal and deafening injuries such as hemorrhaging of the heart and deflated or ruptured swim bladders.

- **Bats use echolocation to communicate** as well as to find food at night, according to a paper in the December 7 issue of *Proc. Royal Society B*, published online Oct. 3. Roosting males seem to detect the echolocation calls of an approaching bat from at least five meters away. In response to an approaching male, they emitted aggressive vocalizations suggestive of territorial defence, but if the approaching bat was female, the males responded with courtship songs. The males must be using echolocation, the authors conclude, because in low-light conditions at a distance of five meters, neither their visual nor odor cues could provide the roosting bats with information about the sex of their visitor.

- **Convergent evolution between insect and mammalian audition** is discussed in a paper in the 16 November issue of *Science*. Comparison of the hearing mechanisms in humans and katydids shows remarkable similarities in both functional and anatomical aspects. In the rainforest katydid, the outer-ear tympanal membranes are coupled to a stiff, leverlike middle ear-like structure, which in turn couples to an elongated

fluid-filled chamber of the inner ear that contains a linear array of sensory receptors. A recent finding is the impedance matching and amplification by a leverlike middle ear-like component, the tympanal plate. This finding was made possible by use of x-ray microtomography, which allows high-resolution imaging of fresh animals or specimens, in conjunction with microscanning laser Doppler vibrometry and 3D reconstruction imaging software.

- The October issue of *Journal of New Music Research* is a **special issue on music performance monitoring**. Music performance investigation lies at the crossroads of several disciplines, such as musicology, acoustics, and human and computer sciences. Monitoring musical performance basically relates to the observation and recoding of multiple aspects of musical performance. The special issue originates from a joint workshop between the Institute for Psychoacoustic and Electronic Music and IRCAM on music performance monitoring held in Ghent, Belgium. The papers included in the special issue illustrate different trends and responses to new issues related to data handling, data analysis, development of sensing devices, and ecological validity of measurements.

- **Why do we recoil at nasty sounds**, such as nails scraping on a blackboard? Heightened activity between the brain's emotional and auditory parts is to blame, according to a study published October 10 in the *Journal of Neuroscience*. The amygdala modulates the auditory cortex response, heightening its activity and producing a negative reaction. Researchers used functional magnetic resonance to map the brains of 13 volunteers as they listened to a variety of sounds. They found the reactions in the amygdala and auditory cortex varied directly to the ratings of unpleasantness of the sounds. An analysis also found that anything in the frequency range of around 2,000 to 5,000 Hz was considered unpleasant.

- Predicting the submarine **underwater structure-borne noise and flow noise due to propeller excitation** is the subject of a paper in the August issue of *Acoustics Australia*. The results suggest that the principal breathing and bending modes plus the resonance mode of the rudders and circumferential modes of the cabins generate strong structural responses. The flow noise occurs mainly around the propeller harmonics. The noise due to the axial force is mainly radiated from the cylindrical hull. The flow noise is lower than the structure-borne noise at the blade-passing frequency and higher than the structure-borne noise at higher harmonics of the blade-passing frequency. Finally, the directivity of the flow noise is asymmetric relative to the axis of the submarine.

- **Near-Field Imaging with Sound: An Acoustic STM Model** is the title of a paper in the October issue of *The Physics Teacher*. The scanning tunneling microscope (STM), invented some 30 years ago, opened up a visual window to the nano-world and sparked off new methods for investigating and controlling matter and its transformations at the atomic and molecular level. However, an adequate theoretical understanding of the method is demanding. A hands-on

continued on page 7

Scanning the journals

continued from page 6

model for demonstrating the imaging principles in introductory physics uses sound waves and computer visualization to create mappings of acoustic resonators. Grounding STM in acoustic experience may help to make the underlying quantum concepts such as tunneling less abstract to students.

- “The Influence of Background Sounds on Loudness and Annoyance of **Wind Turbine Noise**” is discussed in a paper in the September-October issue of *Acustica/Acta Acustica*. A listening test showed that ambient sounds influenced the perception of wind turbine noise to a higher degree than predicted from a model of energetic masking. Annoyance ratings were less altered by background noise than perceived loudness. The results indicate that masking of wind turbine noise by natural sounds may be used as a complement to conventional noise control measures to improve the sound environment in areas exposed to wind turbine noise.

- Directional analysis can be accomplished with a microphone array mounted on a rigid cylinder for **directional audio coding**, (DirAC) according to a paper in the May issue of *Journal of the Audio Engineering Society*. DirAC provides a parametric representation of the sound field, containing data on the direction of arrival and the diffuseness in frequency channels. A rigid cylinder inserted into the array casts an acoustic shadow and causes scattering which produces prominent inter-microphone differences that can be used in direction estimation methods.

- Noise-cancelling headphones can be used to **improve task performance in a noisy environment**, according to a paper in the January issue of *Applied Acoustics*. Subjects were presented with 65-dB(A) noise filtered to simulate noise in an aircraft cabin while they performed a simple mathematical exercise. Performance was considerably better with noise-cancelling headphones.

- Zheng Wang has developed a way to **slow light waves down to the speed of sound** by creating nanometer-size ridges on a chip, according to a story in the September/October issue of *Technology Review*. The ridges are so slender and flexible that they can be deformed by electric fields. When light is delivered by optic wire to the ridges at the edge of the chip, they convert the light waves to high-frequency sound waves, which travel at about a hundred-thousandth the speed of light. The same trick works in reverse after the sound waves have traversed the chip, with the ridges converting the sound back into light to continue its higher-speed journey via optic wire. Sound waves are much easier to read and route within the tiny confines of a chip. And they offer the huge advantage of not generating the heat that electronics do. That makes Wang’s approach promising for applications in information processing, as well as in nanoscale microscopy.

- Most **echolocating bats exhibit a strong correlation between body size and the frequency of maximum energy** in their echolocation calls (peak frequency), with smaller species using signals of higher frequency than larger ones, according to a paper in *Nature* published online November 21. Smaller bats emit higher frequencies to achieve direc-

tional sonar beams, and that variable beam width is critical for bats. Shorter wavelengths relative to the size of the emitter translate into more directional sound beams.

- Handlers at the National Marine Mammal Foundation in San Diego heard mumbling in 1984 coming from a tank containing whales and dolphins that **sounded like two people chatting** far away. According to an online paper in *Current Biology*, an acoustic analysis of whale calls revealed the human-like sounds were several octaves lower than typical whale calls. Scientists think the whale’s close proximity to people allowed it to listen to and mimic human conversation. It did so by changing the pressure in its nasal cavities. After four years of copying people, it went back to sounding like a whale, emitting high-pitched noises.

- **Blind adults taught to “read” using sounds that represent letters** use the same area of the visual cortex that sighted humans use when reading, according to a paper in *Neuron* **76** (93), 640. Using a program that describes images in sound, eight congenitally blind people were taught to decipher the shapes of letters. When the subjects read using the sounds, they activated the same part of the visual cortex as sighted persons did when viewing letters. Users of these sensory substitution devices (SSDs) wear a miniature camera connected to a small computer (or smart phone) and stereo headphones.

- Papers and articles about **“singing sand dunes”** have been mentioned several times in *ECHOES* (see Summer 2006 and Winter 2006, for example). At least two explanations of how sound is generated have been suggested: the “stick-slip” motion of sand grains as they cascade down slopes in sand dunes; and collisions between grains that excite waves outside the shear layer (see Scanning the Journals in the Winter 2006 issue). New research published online in *Geophysical Research Letters* finds that the size of sand grains shapes a dune’s song. Scientists collected sand from a singing dune in Morocco that moans at around 105 Hz—or, to a musician, that’s G-sharp two octaves below middle C. They compared those grains to sand collected from a dune in Oman, which produces notes ranging from 90 Hz to 150 Hz (F-sharp to D). By creating mini-dune avalanches in the lab, scientists recreated these desert songs, finding that different layers of sand aren’t necessary to produce the moans, as previous researchers contended. Laboratory avalanches on a hard plate with singing-dune sand show that there is no need for a dune below the sand avalanche to produce the singing sound. The various frequencies heard in the field avalanches match the shear rates not calculated from the average size, but from the various peaks of the grain size distributions.

- **Echolocation range and wingbeat period are found to match** in aerial-hawking bats, according to a paper in the September 3 issue of *Proc. Royal Soc. Lond. B*. This allows a reduction in the high energetic costs of echolocation. Echolocation calls range to 133 dB peak equivalent sound pressure level. Aerial-hawking bats searching the sky for prey face the problem that flight and echolocation exert independent and possibly conflicting influences on call intervals.



ACOUSTICAL SOCIETY OF AMERICA

SUITE 1N01
2 HUNTINGTON QUADRANGLE
MELVILLE, NEW YORK 11747-4502

Non-Profit Org.
U.S. Postage

PAID

Hanover, PA 17331
Permit No. 4

Acoustics in the News

- Daredevil Felix Baumgartner broke the sound barrier during a skydive from the edge of outer space, according to a story in the October 14 *Washington Post*. Some 24 miles above the Earth's surface, Baumgartner reached Mach 1.24 or 833.9 miles per hour after falling from 128,120 feet above sea level. This means Baumgartner is the first human being to travel faster than the speed of sound without being inside a craft.
- Scientists have enabled deaf gerbils to hear again—with the help of transplanted cells that develop into nerves that can transmit auditory information from the ears to the brain, according to a report in *Nature* posted online September 12. The advance could be the basis for a therapy to treat various kinds of hearing loss. In humans, deafness is most often caused by damage to inner ear hair cells or by damage to the neurons that transmit that information to the brain. Researchers exposed human embryonic stem cells to fibroblast growth factors FGF3 and FGF10. Multiple types of cells formed, including precursor inner-ear hair cells, but they were also able to identify and isolate the cells beginning to differentiate into the desired spiral ganglion neurons. Then, they implanted the neuron precursor cells into the ears of gerbils with damaged ear neurons and followed the animals for 10 weeks. The function of the neurons was restored.
- The Speechjammer, a device that disrupts annoying speech by repeating a speaker's speech with a delay of a few hundred milliseconds, was awarded an Ig Nobel prize, according to a story in the 21 September issue of the *San Francisco Chronicle*. The echo effect of the device is just annoying enough to get the speaker to stutter and stop. Ig Nobel prizes are awarded each year by the *Annals of Improbable Results* magazine.
- Scientists at Argonne National Laboratory acoustically levitate droplets of liquid in order to have them evaporate without touching the walls of any container, according to a bulletin on NBC News September 14. This enhances the production of drugs in an amorphous, rather than crystalline state, making them more highly soluble with a higher bioavailability. The news bulletin implies that acoustic levitation is possible in any standing acoustic wave and does not associate it with nonlinearity. There is a video at http://www.youtube.com/watch?feature=player_embedded&v=669AcEBpdsY
- A new wave of imaging technologies, combining ultrasonic, optical, magnetic, and x-ray imaging, is transforming the practice of medicine, according to a story in the October 9 issue of *The New York Times*. They include new pathology tools to give doctors an instantaneous diagnosis, as well as inexpensive systems, often based on smartphones, that can extend advanced imaging technologies to the entire world. The advances are being driven by the falling cost of computing as well as devices based on nanotechnology.
- A new program, called Innovation Corps (I-Corps), announced by the National Science Foundation (NSF) aims to teach budding scientific entrepreneurs how best to tailor ideas from their NSF-funded research to attract investors, according to a note in the 20 July issue of *Science*. The program developed an 8-week pilot course last fall, and now 54 I-Corps grantees received grants to extend the program. NSF hopes to spend \$19 million on I-Corps in 2013. Each \$50,000 I-Corps grant is shared among a three-member team, a principal investigator on a current or recent NSF grant, a graduate student or postdoc, and a mentor with a history of successful start-ups.
- Blind people, using specialized photographic and sound equipment, can actually “see” and describe objects and even identify letters and words, according to a story in the Nov. 7 issue of *Science Daily* (online). This is possible through a unique training paradigm, using sensory substitution devices (SSDs). For example, using a visual-to-auditory SSD in a clinical or everyday setting, users wear a miniature camera connected to a small computer (or smart phone) and stereo headphones. The images are converted into “soundscapes,” using a predictable algorithm, allowing the user to listen to and then interpret the visual information coming from the camera.