The newsletter of
The Acoustical Society of America

ECHOES

Volume 9, Number 2
Spring 1999

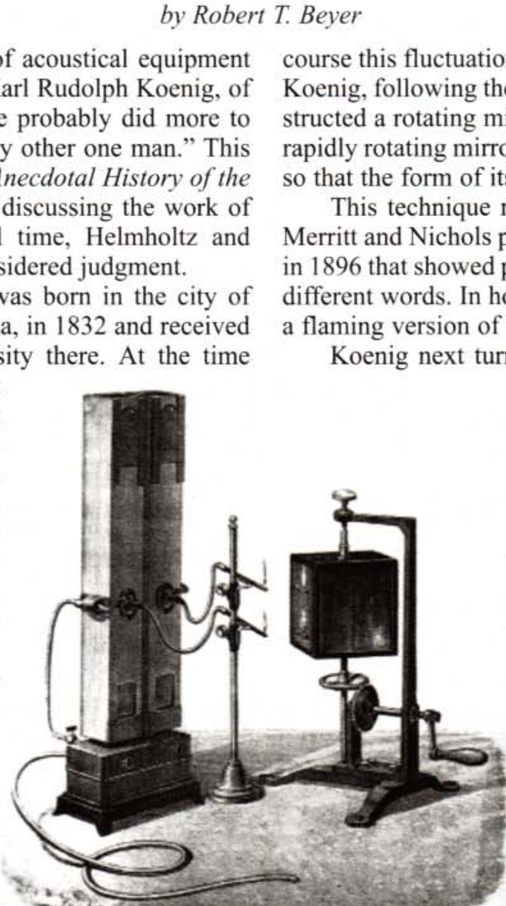
Rudolf Koenig, 1832-1902

by Robert T. Beyer

Perhaps the outstanding maker of acoustical equipment in the nineteenth century was Karl Rudolph Koenig, of whom Dayton Miller wrote "he probably did more to develop the science of sound than any other one man." This encomium appears in Miller's book *Anecdotal History of the Science of Sound*, between passages discussing the work of the two greatest acousticians of all time, Helmholtz and Rayleigh. It was therefore a well-considered judgment.

Appropriately enough, Koenig was born in the city of Koenigsberg, now Kaliningrad, Russia, in 1832 and received his academic training at the university there. At the time Koenig was a student, von Helmholtz was a Professor of Physiology at Koenigsberg and, while there is no record of any association, one would like to imagine some contact between the young acoustician-to-be and the great von Helmholtz.

A few years after taking his degree, Koenig moved (about 1860) halfway across Europe, to Paris, where he studied violin making under one of the master violin makers of the day, Vuillaume. Very soon, however, Koenig started his own business making acoustical apparatus, which he did with exquisite care and talent. He devoted the rest of his life to this work, more than forty years of making the best acoustical instruments of his day.


Manometric Flame & Rotating Mirror

In the early part of the nineteenth century there was a great effort made toward the visualization of sound waves. John Le Conte, who taught at what is now the University of South Carolina, noticed at a musical concert in the late 1850's that the flame of a gaslight rode up and down with the music. This phenomenon later caught the attention of Bell and Tyndall and also Koenig, who, in 1864, produced a working device to study such flames, called the manometric box or capsule. When a sound-produced compression entered the box, the flame burned more brightly, when a rarefaction appeared, its intensity was diminished. Of course this fluctuation was too rapid for the eye to follow, but Koenig, following the lead of some work of Wheatstone, constructed a rotating mirror. When the flame was viewed in the rapidly rotating mirror, the flame appeared spread out in time, so that the form of its fluctuations could be discerned.

This technique remained popular for nearly fifty years. Merritt and Nichols published a paper in the Physical Review in 1896 that showed pictures of these flames corresponding to different words. In honor of the inventor, one picture showed a flaming version of "Doctor Koenig."

Koenig next turned his attention to the manufacture of tuning forks. Earlier in the century, Scheibler in Germany had shown how to standardize the pitch of a musical instrument by first constructing two forks, one for the A above middle C, and one for a tone an octave below. Then he made a set of forks, each one vibrating at four cycles per second faster than the one before, starting from the lower A mentioned above. He found that it required 55 forks to take him from one A to the other. He therefore inferred that the interval between the two A's amounted to 220 cycles per second, and that the upper A was therefore at 440. This became known as the Stuttgart pitch. Scheibler did this in 1834, but the pitch was not accepted throughout the world for another 80 years.

In studying this pitch Koenig constructed a set of 670 forks similar to Scheibler's, but covering a range of four octaves. He took these to the American Centennial Exposition in Philadelphia in 1876 and was awarded a gold medal for his researches. He was promised that a subscription would be raised to buy the forks for an American museum, but it fell through, leaving him a rather embittered man. The forks ultimately found their way to the U. S. Military Academy at West Point, where they were put on exhibition.

In an attempt to make his measurements more precise,

continued on page 6

Society Pages

We hear that...

James V. Candy, Lawrence Livermore National Laboratory, has been elected a fellow of IEEE (Institute of Electrical and Electronics Engineers). Jim is a fellow of ASA and serves as Chair of the Interdisciplinary Technical Group on Signal Processing in Acoustics.

Patricia K. Kuhl, William P. and Ruth Gerberding University Professor and Chair of Speech and Hearing Sciences at the University of Washington, gave the Twenty-third Annual Faculty Lecture on the subject "Language, Mind, and Brain: How Infants Crack the Speech Code." The lecture, given to a packed house, was televised for showing on the university TV station and for distribution to high schools.

Harry Levitt, City University of New York, received the (New York) Mayor's Award for Excellence in Science and Technology, recognizing his research which serves "the disabled community as well as the general welfare of our city and its citizens." Harry is a fellow of ASA.

Andrew F. Seybert, professor of mechanical engineering at the University of Kentucky, has been named a fellow of ASME International (The American Society of Mechanical Engineers). Andy is a fellow of ASA.

Jason T. Weissenburger, founder and president of Engineering Dynamics International (St. Louis), has also been named a fellow of ASME International.

Daniel Johnson, Bruel, Bertrand and Johnson, was awarded the Outstanding Hearing Conservationist award by NHCA (National Hearing Conservation Association). Dan is a fellow of ASA and also serves as Standards Director.

Also receiving awards from NHCA were **Dennis Driscoll**, Associates in Acoustics, who was awarded the Outstanding Lecture Award for his presentation "Noise Control Survey Procedures," and **William Clark**, Central Institute for the Deaf, who received the Oustanding Poster Award (with Nancy Nadler) for a poster presentation "From the Lab to the Living Room: Are Noisy Toys Hazardous to Hearing?"

Cyril M. Harris, Columbia Univeristy, received the Pupin Medal from the university for "distinguished service to the nation in science and technology.

ECHOES

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
Graphic Design .... Jim Nelson
Printing .... Ram Offset
ASA Editor-in Chief .... Allan Pierce

Phone inquiries: 516-576-2360. Contributions should be sent to Thomas Rossing, Physics Dept., Northern Illinois University, Dekalb, IL 60115 <Rossing@physics.niu.edu>

From the Editor

The circle of readers of *ECHOES* continues to grow. Formerly mailed only to ASA members in North America, it is now sent to all ASA members plus school teachers that request it. In the interest of publications and education of future acousticians, I would like to see it in every high school library, at least until an acoustics magazine for high school students is created. We have received several requests to reprint *ECHOES* articles, which we not only grant (with the author's consent) but encourage. Thanks to Carr Everbach, *ECHOES* will soon appear online.

We encourage contributions from **our readers**. Short contributions and Letters to the Editor are especially welcome. Deadlines are tied to ASA meetings: *one month after and two months before each ASA meeting*. Contributions that arrive well in advance of the deadlines bring smiles to the Editor! Submit your contributions on paper or electronically (plain text preferred). Photos are always welcome.

From the Executive Committee

- The ASA membership will vote on changing the by-laws to include the most recent past vice president as a member of the Technical and Executive Councils.
- Preregistration for the Columbus meeting will be $200, and $250 after September 20 or at the door. Students will continue to register for free. Accompanying persons will be charged at cost for socials.
- A hard deadline for A/V requests will be two weeks before meetings. A $50 fee will be charged for providing computer projection equipment.
- A joint meeting with the Mexican Acoustical Society and Federación de Acustica (FIA) was approved for Cancun, Dec. 2-6, 2002. A site in New York is under investigation for the 75th Anniversary meeting in 2004. A joint meeting in Honolulu with the Acoustical Society of Japan was approved for Fall, 2006.
- A task force, chaired by Ilene Busch-Vishniac, will review the entire range of services provided to the ASA by AIP.
- An investigation into the possibility of changing the ASA Membership Directory and Handbook by making it available on-line with the option for members to purchase a paper copy has been initiated.

Pat Kuhl & Elaine Moran at the Berlin meeting

Congratulations, Elaine!

Elaine Moran, ASA Office Manager, was presented a Distinguished Service Citation at the Berlin meeting "for sustained and dedicated service to the Acoustical Society, its officers and members, over many years." Elaine's work is vital to every aspect of the Society, including *ECHOES*. Please join the Editor in expressing our heartfelt thanks to Elaine for her countless contributions to the Society!

Big Meetings–Small Meetings

by Charles Schmid

We all thought the International Congress on Acoustics (ICA) in Seattle last year would be the largest gathering of acousticians before the new millennium; that was until 2,250 showed up in Berlin at the ASA's joint meeting with the European Acoustics Association and German Acoustical Society in March! These two large meetings offered scientists and engineers the opportunity to learn about a wide range of work in acoustics being carried out around the world. Many older members were reunited with colleagues they hadn't seen in years, and younger members got acquainted with acousticians whom they will undoubtedly meet again in years to come.

However something is lost at these large international meetings. With so many attendees and so many parallel technical sessions, members said that the "home town" atmosphere, which is a hallmark of ASA meetings, all but disappeared. This is why the Society plans to continue with its typical smaller meetings for the next few years, expecting attendance numbering less than 1,000 such as at Norfolk last Fall.

On the far side of the spectrum of meeting sizes are the workshops that ASA organizes to bring a small group of people together to discuss selected topics in acoustics. These satellite meetings can be held at ASA meetings, or at another time and place. In April, for example, 50 people gathered in Morro Bay, California to discuss the Acoustics of Themed Entertainment. Technical backgrounds were as diverse as architectural acoustics, psychoacoustics, noise, sound design, signal processing and construction. Responsibilities ranged from owners to consultants, from manufacturers to university researchers, from speaker designers to community noise experts. A primary conclusion was that more workshops like this were needed to bring cross disciplines together to foster understanding of each other's requirements to design and build theme parks, amusement parks, outdoor performance centers and movie theaters. Solutions covered everything from how to minimize screams from roller coaster riders by using proper placement of loops, to using active control and speaker arrays to reduce noise levels. It was refreshing to see an emphasis on the latter half of ASA's stated purpose, "to increase and diffuse the knowledge of acoustics *and promote its practical applications.*"

The initiation and planning of ASA meetings relies on volunteers. ASA will provide the necessary support, both in terms of finances and staff. If you are interested in hosting a big national meeting or a small meeting on a special topic, please contact us at the ASA and we'll work together on it.

Charles Schmid is Executive Director of the Acoustical Society.

ASA Launches ARLO

by Robert Apfel

ARLO, Acoustics Research Letters Online, is a new rapid publication letters section in the Journal of the Acoustical Society of America. It will accept short articles (up to 6 single column pages) that represent substantially new and significant contributions to any aspect of the scientific/engineering literature in acoustics, rather than minor variations on prior work. Unique observations of phenomena (e.g. via original audio/video or through computer simulation) that are illustrated in multimedia files are encouraged, provided they represent a new and significant contribution and are augmented by analysis and/or interpretation.

ARLO is the first refereed journal produced under the auspices of the American Institute of Physics that includes refereed multimedia content. Now, for example, papers in speech or animal bioacoustics can include sounds, and video clips can be included that illustrate the effects of acoustic waves on physical phenomena.

ASA has also pioneered a novel online Manuscript Management System for the submission and review of articles. Manuscripts are submitted as postscript documents over the web according to prescribed Style Guidelines. Authors, Associate Editors, and Reviewers all view the manuscripts they are involved with on the web and communicate via the web and email. The process, which is described in detail at <.asa.aip/arlo>, will allow manuscripts that are pretty "clean" (requiring only minor revision) to be published online in as little as one month after submission (with subsequent appearance in the print version of JASA).When articles are published, they are viewed as PDF documents (which can be read by Acrobat Reader), and the title, authors, abstract and references are also available as searchable/linkable documents.

ARLO gives special benefits to authors, as described above, and in return expects authors to provide support through mandatory per article charges ($350 for accepted manuscripts) and to play a more significant role in the manuscript preparation process.

A key element in the success of ARLO will be encouraging JASA reviewers to register online (at http://aip.org/asap/register.html) to be listed as possible online reviewers for ARLO. In order to encourage past JASA reviewers to register, the ASA will hold a drawing for a new slim laptop computer (value $2000) after 1000 people have registered.

Do you have a possible new submission for ARLO? It is an excellent opportunity to get your latest research out to JASA readers quickly, and it permits you to enhance your message with color and multimedia, so long as this material adds substantively to content of the article.

Robert E. Apfel, editor of ARLO, is the Robert Higgin Professor of Mechanical Engineering at Yale University. Bob is a former president of ASA and a frequent contributor to ECHOES. His telephone number is 203-432-4346 and his email is: robert.apfel@yale.edu.

Position Available
Treasurer, Acoustical Society of America

The Acoustical Society of America seeks applications for the position of Society Treasurer. The Treasurer is the chief adviser to the ASA Executive Council (EC) on all business and financial matters, and is responsible for all funds, securities, and other property of the Society. The Treasurer is responsible for business transactions of the Society and periodically makes financial reports to the EC and to members of the Society as required by the EC.

The ASA Treasurer's major responsibilities include preparing annual budgets covering all income and expenses for approval by the EC, coordinating the work of the ASA auditor to submit an independently audited statement of the Society's income and expenditures for the previous year, arranging for filing of the Society's tax returns and payment of taxes, maintaining the permanent files of the Society's financial and tax records and reports, and, with the Investments Committee, supervising the managed portfolios of invested funds.

The ASA Treasurer attends twice-annual meetings of the Society and of the ASA's Officers and Managers. Periodic visits to the ASA Office in New York to interact with the auditor, accountant, and office staff are also required. The Treasurer also represents the Acoustical Society on the AIP Committee of Society Treasurers.

It is anticipated that the time requirements of the position would be approximately two days per week. Salary is negotiable. A background in financial management, budget preparation, and financial projection is desirable, as is knowledge of the goals and operations of the Society.

Candidates should submit a cover letter describing their interest in and qualifications for the position, together with resume/vita, to:

Janet M. Weisenberger, Ph.D., Associate Dean
College of Social and Behavioral Sciences
Ohio State University
1010 Derby Hall, 154 N. Oval Mall
Columbus, OH 43210
(614) 688-3167 (phone) (614) 292-9530 (fax) jan+@osu.edu

Interested candidates are urged to apply. Nominations of qualified individuals are also welcome. Review of applications will begin September 1, 1999, and will continue until the position is filled.

Echoes From Berlin

Ants Have an Acoustic World of Their Own

by Robert Hickling

It is well known that ants do not respond to sound on a human scale. You can shout at an ant, and it doesn't seem to notice. Yet many ant species communicate by means of squeaking sounds generated by a stridulatory organ on the ant's body, consisting of a washboardlike set of ridges and a scraper. The squeaking sounds are usually very faint but they pervade ant communities.

The amplified sounds of a colony of black fire ants (Solenopsis richteri), disturbed by a microphone probe pushed into their mound, can be heard on the web at <www.olemiss.edu/~hickling/>. Sounds from individual ants can be heard clearly, and there are a number of different signals. Ant sounds occurring in other situations can also be heard at the web site. The sounds are in the audible range around 1 kHz. Because ants appear to be deaf to airborne sound on a human scale, myrmecologists have inferred that they transmit stridulation signals through the soil, or other substrate. However, for a number of reasons, this mode of transmission is highly unlikely. A more likely explanation is that ants communicate with each other using nearfield sound, through the unchanging medium of the air. The nearfield is an acoustic transition zone surrounding a small source, the size of an ant, in which the characteristics of the sound change abruptly before it becomes fully propagating in the far field. Usually an ant is a few millimeters in size and the surrounding nearfield is roughly 200 mm in diameter, which is large enough to contain a number of ants.

As with other insects, ants are believed to "hear" airborne sound with their antennae, using hairlike sensilla at the tips. By sensing the relative difference in sound displacement between the tips of the antennae, an ant can detect stridulation signals in the nearfield, where displacement changes rapidly with distance, but can not detect sound in the far field, where displacement changes much more gradually. This explains how ants can detect sound from other ants, while, at the same time, they are unaware of sound on a human scale. This is fortunate for ants because they would otherwise be overwhelmed by irrelevant background noise, both natural and manmade. As an added bonus, sensing the relative displacement between the tips of the antennae provides a means of determining the distance to a source in the nearfield, as well as the direction of the source. Humans can determine direction but not the distance to a source, because the source strength is not known. Usually we determine the location of a sound source using a combination of hearing and vision. For ants, the relative difference in displacement between the tips of the antennae is independent of source strength and provides a one-to-one relation with distance that can be used to determine distance directly. Because they appear to have limited vision, the ability to determine the distance to a source purely by means of sound would obviously be useful to ants.

The nearfield is an acoustic effect that exists independently of ants. Because it is ideally suited to their needs, it would be surprising if ants did not use it. In fact it would seem that the stridulatory organ and acoustic receptors of ants have evolved to take advantage of the nearfield.

A more complete knowledge of the nearfield and how ants use it will aid greatly in understanding the role of acoustic communication. Combined with chemical communication using pheromones, acoustic communication plays an important role in ant societies. Of course, making use of relative differences in displacement, between two regions of reception in the nearfield, need not be confined to ants.

Robert Hickling is at the National Center for Physical Acoustics, University of Mississippi. (See Berlin paper 2aAB1)

Opening Ceremony at the Berlin Philharmonic

Press Conference in Berlin

by Ben Stein

The Berlin meeting was a time of firsts not only for ASA and its sister organizations in Europe; it also represented one for my organization, the American Institute of Physics, where I help to publicize ASA meetings by distributing news releases about them to science reporters at newspapers and magazines. This time around, we teamed up with the Technical University (TU) of Berlin to hold a press conference at the meeting, making this, to my knowledge, AIP's first media publicity work outside North America.

With their broad range of topics in a single setting, ASA meetings have been popular with science reporters in North America and Europe. Coverage of last year's meetings appeared in US News and World Report, National Public Radio, Discover, the Economist, ABCNEWS.com, the BBC, and many other places. So when ASA joined together with the German and European acoustics societies to hold a meeting in Berlin, we saw it as a great opportunity to reach out to a new audience: science reporters in Europe.

The Berlin news conference provided an opportunity to introduce German science reporters to the diverse and interesting world of acoustics that we all know. For my part, I helped to identify speakers with interesting new results that would be of direct interest to the general public (there were too many, so I had to narrow it down tremendously!). The TU Berlin Press Office, working with meeting cochair Michael Möser of the TUBerlin, sent a German language version of my news release to 800 reporters in Germany, secured a room, and did much of the hard logistical work in the weeks leading up to the event.

The press conference met our expectations. First were introductions by ASA president Jim West and his European and German counterparts, along with meeting cochairs Möser and Jiry Tichy. Then, about 10 meeting presenters briefly described their work in German or English; the reporters understood both.

For example, Geoffrey Lilley of NASA/University of Southampton described how the silent flight of the owl might provide insights into how to design less noisy nextgeneration airplanes. Joerg Sennheiser, chairman of Sennheiser Electronics, described a new microphone design that does not require the thin outer covering known as a "membrane" which is the part of the microphone that affects the quality most.

After the formal presentations ended, reporters huddled around the various presenters, asked questions, took notes, and recorded comments with an intensity that was a joy to behold. The press coverage was equally gratifying. Numerous stories appeared in Berlin newspapers (such as *Berliner Zeitung*), national newspapers (including *Die Welt*), radio stations (Deutschlandfunk), and the largest TV network in all of Germany (RTL). Juergen Altmann, who told the news conference attendees about his watchdog investigations of nonlethal "acoustic weapons" rumored to be in development, said that he went into his car shortly afterward and heard himself on German National Public radio!

For the week that we were Berlin, it would not be an exaggeration to say that a wave of enthusiasm about acoustics rippled through Germany.

Ben Stein, a staff member of the Office of Public Information at the American Institute of Physics (AIP), is well known to ASA members. He attends most of our meetings, arranges press conferences, and edits both the World Wide Pressroom (online) and the lay language papers.

Time Discrimination in Birds

by Robert J. Dooling, Marjorie R. Leek, and Michael L. Dent

For a number of years, there have been speculations that birds may be specialized for resolving fine temporal detail in complex acoustic waveforms. These speculations have come from anatomical studies suggesting greater damping in the avian inner ear, from physiological studies showing excellent time resolution of single neurons in the auditory periphery, and from behavioral studies showing that birds can and do learn to produce the fine acoustic detail in their speciesspecific vocalizations. It is puzzling, therefore, that rigorous psychophysical experiments with birds over the past several decades have failed to find much evidence of this specialization. On many measures of temporal processing, including maximum and minimum temporal integration and duration discrimination, birds show sensitivities similar to those of humans and other mammals. However, these tests all involve envelope changes in a single auditory channel rather than changes in the temporal fine structure of a sound or changes which occur over several auditory channels.

More recent studies of temporal processing indicate that on frequency difference limens for short duration tones, discrimination of gaps in sinusoidal markers, and detection of a mistuned harmonic, birds are much more sensitive than humans to certain temporal aspects of complex sounds. We conducted a series of tests with sets of harmonic complexes that had identical long-term spectra but variable phase spectra, producing waveforms differing systematically in envelope shape or fine structure. We used operant conditioning and standard animal psychophysical procedures to test the ability of budgerigars (Melopsittacus undulatus) to discriminate between waveforms with identical envelopes, but different fine structures, at a number of fundamental frequencies. Results showed that birds could make these discriminations for fundamental frequencies approaching 1000 Hz. In other words, the birds could discriminate changes that occurred within a harmonic period as brief as 1 ms. Humans tested on the same stimuli could not discriminate these changes in harmonic complexes with fundamental frequencies greater than about 250 Hz (a 4ms period).

The most common tool for displaying and analyzing animal sounds is still a frequency/time plot (Sonogram or frequency spectrogram). Bird vocalizations which look similar in such a plot might still vary considerably in their temporal fine structure. Two vocalizations that appear similar to an experimenter may actually sound different to a bird's ear. It is not yet clear how birds use this capability. It may be useful for individual recognition or in judging the source of vocalizations as they travel through cluttered environments. But no matter, these results strongly support the longheld belief that birds are more sensitive than humans and other mammals to temporal aspects of complex acoustic signals, including species-specific vocalizations. [Supported by NIH DC00198]

Robert J. Dooling and Michael Dent are in the Department of Psychology at the University. of Maryland, College Park. Marjorie Leek is at the Walter Reed Army Medical Center in Washington.(See Berlin paper 3aABb1)

Steerable Microphones

by Gary W. Elko

An array of closely-spaced pressure microphones can be combined with signal processing algorithms to maximize the signal-to-noise ratio obtainable from microphones for teleconferencing and other applications.

The simplest arrangement uses two microphones in a first-order differential array with a single spatial null. To obtain a simple adaptive microphone, each microphone output is subtracted from a time-delayed output of the other microphone. The resulting two signals are then equivalent to signals from two back-to-back cardioid microphones. By multiplying the rear-facing cardioid by a scalar and subtracting from the forward cardioid, any general first-order differential microphone can be realized (the beam pattern is described by a constant term plus an angular-dependent term). An adaptive microphone can now be easily formed by allowing the scalar term to be variable and determined by the individual cardioid output signals. The optimum placement of the null (minimum output power) can be determined by calculating the auto and cross correlation coefficients of the forward and rear-facing cardioids. The scalar coefficient can be constrained to control the allowed spatial locations for the single null.

A three-element microphone arrangement forms a second-order differential array with two independent nulls,

continued on page 6

Echoes From Berlin

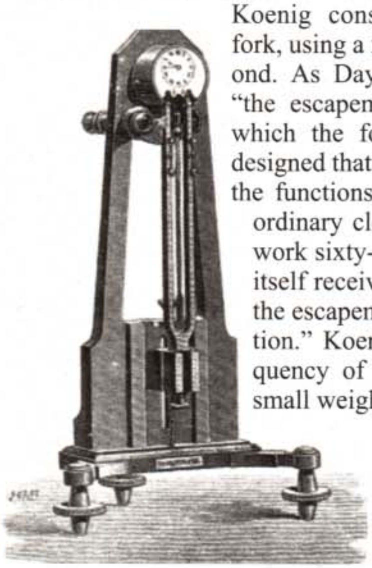
...Berlin, continued from page 5

whereas a six-element array can form a first-order differential adaptive microphone that can have nulls in any direction. This is accomplished by using the pressure difference between pairs of microphones and then multiplying by an appropriate steering vector to form back-to-back cardioids in any direction. When the cardioid signals are derived, the adaptive processing can be applied. A four-element tetrahedral array of pressure microphones can be designed to be roughly equivalent to the six-element array.

Gary Elko is in the Acoustics and Speech Research Department at Bell Labs, Lucent Technologies, where he works on electroacoustic transducers and signal processing for communication systems.(See Berlin paper 2pSPa1)

Rudolf Koenig

...Koenig..., continued from page 1



Tuning Fork Clock

Koenig constructed a clock-tuning fork, using a fork of 64 cycles per second. As Dayton Miller describes it, "the escapement of the clock, with which the fork is connected, is so designed that the tuning fork performs the functions of the pendulum of an ordinary clock, releasing the wheel work sixty-four times a second, and itself receiving a minute pulse from the escapement wheel at each vibration." Koenig could adjust the frequency of the fork by the use of small weights attached to the prong. By comparing his system with a standard clock, he was able to calibrate his forks with great accuracy, and thus to calibrate other forks by comparison. Some of these forks were very large, weighing as much as 200 lb.

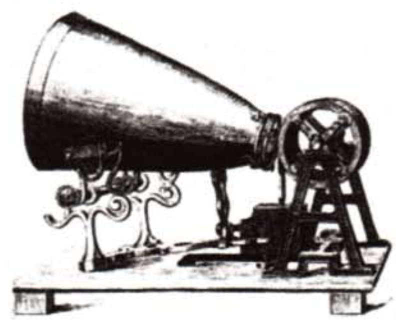
Koenig also interested himself in the upper frequency threshold of hearing and recorded that at age 45 he could hear 23,000 Hz, at 57, 20,480 Hz, and at 67, 18432 Hz, marking the presbycusis of an otherwise healthy ear.

At this stage of his career, Koenig interacted with von Helmholtz in a number of ways. He manufactured a set of glass Helmholtz resonators for Helmholtz to use, and himself used a cylindrical Helmholtz resonator to amplify the sounds of his sustained tuning fork vibrations, which were very similar to those described Helmholtz in his book.

Despite their frequent cooperation, Koenig and von Helmholtz did have a substantial disagreement about the influence of the phase of upper partial tones on what we hear. Helmholtz laid down the law: "differences in musical quality of tone depend solely upon the presence and strength of partial tones, and in no respect on the differences in phase under which these partials enter into combination." According to Lloyd Jeffress, in a paper in 1962, Helmholtz did hear a phase-determined auditory effect, but dismissed it as only an *apparent* exception to his rule. Koenig was able to monitor monaural phase effects with his wave siren. Jeffress pointed out a great list of famous acousticians, Firestone, Egan, Lawrence, Licklider, and Schroeder, all of whom have confirmed what Koenig maintained "monaural detectable changes which are related to phase changes in tonal stimuli."

Another interest of Koenig was the synthesis of tones. He used his wave siren in this work, along with smaller and smaller tuning forks. These minute forks (one had prong lengths of 2 mm) emitted sounds that were no longer in the audible range, some of them being as high as 90 kHz. To detect them, Koenig made use of a Kundt's tube to measure the wavelengths involved. In this work, Koenig was pioneering in ultrasonics, but that was for the next century.

In addition to his ultrasonic work, Koenig came close to another phenomenon of the next century–the phonograph. In 1857 he and a French scientist Leon Scott perfected the phonautograph, a device for the recording of sound. One can see great similarities between this instrument and the phonograph invented by Edison some 20 years later.



Scott-Koenig Phonautograph, 1857

In the death notice for Koenig in *Nature* in 1901, its author (initials S. P. T., probably Silvanus P. Thomson) wrote "I once asked him whether, when he was working with M. Scott on this instrument, it had not occurred to either of them that the record of the vibrations might not be used over again to reproduce the sound, discovered nearly 20 years afterwards by Edison. His reply was, 'no, the idea never occurred to either of us; we never thought of anything except recording.'"

In 1882 Rudolph Koenig published a book recounting most of his papers up to that time. On the title page of that book, after his name, were the words "Docteur en Philosophie, Constructeur d'Appareils d'Acoustique"—"Doctor of Philosophy, Constructor of Acoustical Apparatus." He was the Brüel and Kjaer of his day, and for that we salute him.

Robert Beyer, professor emeritus of physics at Brown University, has served ASA in many ways, including president (1961-62) and treasurer (for 20 years). He is the author of Sounds of Our Times, *a history of acoustics during the past 200 years. (See paper 3aPA9, 136th ASA meeting, Norfolk)*

Scanning the Journals

Thomas D. Rossing

- The latest explanation of single bubble luminescence, which describes both the bubble dynamics and the emission of light, appears in an article by S. Hilgenfeldt, S. Grossmann, and D. Lohse in the April 1 issue of *Nature*. The proposed model, according to the authors, relies on the Rayleigh-Plesset hydrodynamic analysis of bubble dynamics and gas diffusion theory. It appears to accurately explain the spectral shape, wavelength independence, pulse width, and intensity of the emitted light.

Comments on this paper by Robert Apfel (on p. 378 of the same issue) may be even more interesting to most *Echoes* readers. Bob briefly reviews the history of sonoluminescence since it was first observed by Felipe Gaitan in 1989, and comments on Seth Putterman's earlier suggestion that the explanation of sonoluminescence might require an entirely new physical principle.

- A brief commentary on current research in sonoluminescence by Felipe Gaitan appears in the March 1999 issue of *Physics World*. Although most of the interest in sonoluminescence has focused on explaining how the light is produced, to some scientists the remarkable stability of the bubble is just as fascinating. Experiments by Ketterling and Apfel (*Phys. Rev. Lett.* **81**, 4991 (1998)) seem to confirm that chemical reactions are responsible. Chemical equilibrium is reached when the amount of nitrogen and oxygen entering the bubble during each sound-wave cycle is equal to the amount that reacts. When only nitrogen is present, the bubble decreases in size and eventually disappears without exhibiting sonoluminescence, but a bubble filled with pure argon can be trapped by sound waves above a certain amplitude and increases as the pressure is increased.
- "Probing the Shaking Microworld" is the title of a report on scanning acoustic microscopes in the 16 April issue of *Science*. The report focuses particularly on papers at session 2aPAb of the Berlin meeting, particularly the invited papers by Eduard Chilla of the Paul Drude Institute for Solid State Electronics in Berlin and by Andrew Kulik, Swiss Federal Polytechnic Institute in Lausanne. Chilla's group has used both a scanning acoustic force microscope (SAFM) and a scanning acoustic tunneling microscope (SATM) for measurement of high-frequency surface acoustic waves. Their methods are based on the mixing at the nonlinearities of tip-to-sample interactions. Amplitude and phase of surface oscillation can be imaged with a lateral resolution in the nanometer range. Although microscope probe tips can't keep up with oscillations above several hundred kilohertz, they are able to glean information on high-frequency waves by allowing the tip to skim the surface of the waves, registering their amplitude without following their every up and down. From this information, the local elastic properties of the material at high frequency can be derived.

In a variation on this technique, Kulik and his group hold the microscope tip absolutely steady so that the oscillating surface bumps into it. Analyzing how the tip vibrates when it touches the vibrating surface reveals the local elasticity to a depth resolution of abut 100 nanometers. Similarly, a team at the Fraunhofer Institute for Nondestructive Testing in Saarbrücken, led by Walter Arnold, pokes the tip into the surface so that it moves with it. The surface is deformed and the deformation field allows them to deduce the elasticity of the sample. Their system is so sensitive that it can detect differences in the elasticity in the small areas in magnetic materials in which the magnetic field is oriented in different directions. A collection of six European teams, known as the Atomic Force Microscopy and Microacoustics Consortium, is funded by the European Union.

- Molecular dynamics simulations of a moving dislocation in a crystalline solid indicate that dislocations may travel faster than the speed of sound, according to a paper by Peter Gumbsch and Huajian Gao in the February 12 issue of *Science*. Under normal deformation conditions, dislocation motion is determined by thermally activated processes and remains relatively slow, but under high strain they can speed up to approach the speed of sound. The new studies show that dislocations can move faster than the speed of sound if they are created as supersonic dislocations at a strong stress concentration and are subjected to high shear stresses. This may be relevant for the dynamics of tectonic faults, the authors point out.
- The resonant frequencies of cochlear hair cells in lower vertebrates, which depends on the gating kinetics of calcium-activated potassium (BK) channels, can be lowered substantially by alternative splicing of the *slo* gene, according to a paper in the January 8 issue of *Science*. According to the authors, who are at Johns Hopkins University, combination with accessory β subunits slowed the gating kinetics of α splice variants but preserved relative differences between them.
- Comments by Georges Canévet and four other researchers on an earlier note by John Neuhoff (*Nature* **395**, 123; see *Echoes* **9**(1) 6) appear in the April 22 issue of Nature, along with a reply by Neuhoff. Neuhoff earlier reported that listeners overestimate the change in level of sounds that get louder as compared to sounds that start loud and get softer. Canévet, et al. point out that twelve years ago they reported that tones continuously decreasing in intensity from moderate to very low levels follow a course of accelerated "softening" until the end of the downsweep. The underlying mechanism for this phenomenon ("decruitment") is unknown, but arguments have been made for both central and peripheral factors. They discuss ways to explain this apparent conflict.

Echoes from Atlanta: Celebrating the APS Centennial *by Thomas D. Rossing*

With the exciting Berlin meeting ("the biggest acoustics meeting ever held") still ringing in my ears, I moved on directly to "the biggest physics meeting ever held," the joint meeting of the American Physical Society and the American Association of Physics Teachers in Atlanta. At this meeting we celebrated the 100th anniversary of the American Physical Society, and what a gala celebration it was! (Those of us who might not be around for ASA's centennial hope for a gala 75th anniversary celebration).

I was able to inject some musical acoustics into the Atlanta festivities by organizing a special session on Physics and the Arts, which attracted a standing-room-only audience. To attract physicists from other areas of physics, ASA vice-president Bill Hartmann used the clever title "Tone-tone Collisions in the Human Brain–Fusion, Fission, Absorption and Scattering" for his review of the psychoacoustics of pitch. Ron Edge included several acoustics demonstrations in his talk on "Demonstrations Experiments and Serendipitous Research from a Course on Physics in Art and Music," while I argued for including more acoustics in physics courses in my talk on "Teaching the Physics of Music and Visual Arts."

Special events at Atlanta included an International Reception/Banquet, a black-tie gala at the Fernbank Museum, and public lectures at various locations around the city. Guests at a special dinner were Nobel laureates as well as an outstanding high school physics teacher from each state. In addition to the public lectures, there were popular physics talks by well-known physicists and physics teachers aimed at students and teachers from the public schools (but well populated by meeting attendees as well!). There were dozens of talks by Nobel laureates as well as by government officials, past and present. I enjoyed representing the ASA at a luncheon for AIP member society officers (thank you, Jim, Pat, Charles, etc. for the free lunch) and delivering a letter from ASA president Jim West.

Acoustics in the News

• "The toll of toxic noise" is the cover story of the April 26 issue of *U.S.News*. "Americans are losing their hearing faster and younger, and a major culprit is recreation: from rock concerts to NASCAR races, from sport shooting to leaf blowing. Advocates for the hearing-impaired say a public awareness campaign is long overdue." The story points out that Americans are losing their hearing at younger ages than before; one study showed that 15% of young people 6 to 19 years old showed signs of hearing loss. Although millions of older Americans lost their hearing in steel mills or mines, or in the military, hearing impairment these days is increasingly associated with home activities and recreation: gas-powered leaf blowers, stereos, rock concerts, hair dryers, and even children's toys. Most of the story is anecdotal, including a lady who claims that an air bag injury made her ears so sensitive to sound "that she must double up on earplugs and earmuffs just to go to the supermarket."

• In Fort Lupton, Colorado, municipal judge Paul Sacco requires people convicted of violating the city's noise ordinance to listen to music they don't like, according to an AP story. Noise scofflaws–most of whom got in trouble for playing their stereos too loud–gather once a month to listen to court-selected songs. The offender are mostly young, so there is a heavy does of "lounge" music, plus Navajo flute music, bagpipes and John Denver songs.

• Euseblo Sempere's outdoor sculpture of metal rods in Madrid inspired two Spanish physicists to "invent" a new method for canceling noise, according to a news note in the May issue of *Popular Science*. Although they found that the street-side sculpture did not have a real sonic band-gap, they built their own array of rods in an anechoic chamber and found that certain frequencies were not transmitted through the array. Such patterns may someday be used in novel materials that would block specific frequencies of sound.

• If you have a degree in science or engineering, the chances are only 2 in 5 that you work in a science and engineering occupation, according to a 1995 NSF survey cited in the April issue of *The Industrial Physicist*. However, 80% of those with masters or doctors degrees that worked in non-science and engineering occupations reported that their jobs were closely related to their degrees. The most common job categories were management, administration, sales, marketing, and unrelated teaching. Data from a similar survey in 1997 is expected to be released soon.

• Engineers seeking to design quiet airplanes are taking a look at the owl, a predator that flies so silently its prey doesn't hear it coming, according to a story carried by *Discovery Online*. Geoffrey Lilley, NASA Langley and University of Southampton, reviewed 50 years of study of the "silent" flight of the owl in paper 1pNSd at the Berlin meeting. Design features that account for the silent flight include the leading edge comb, the trailing edge fringe, and the upper wing cover of velvety down feathers. Putting a serrated edge on the front of an airplane wing is certainly feasible and might help noise reduction, according to Lilley.

• Talking to plants to keep them healthy is considered crazy enough, but listening to them? That's exactly what chemists Sherald Gordon and Richard Greene of the National Center for Agricultural Utilization Research in Peoria, Illinois propose doing to weed out kernels of corn that could end up poisoning your cornflakes, according to a story in *New Scientist*, April 17. The scientists used Fourier Transform Infrared Photo acoustic Spectroscopy (FTIR-PAS) to record the kernels' moans and groans, which are then analyzed by neural network software written at the University of Illinois. Telltale noises are made by moldy kernels when they are bombarded with an infrared strobe light. The dissipating heat produces sounds which are different for clean and moldy kernels.

• The International Space Station will be so noisy that astronauts may struggle to communicate, suffer poor health, and even miss crucial warning tones that signal an emergency, according to Charles Seife in *New Scientist*, April 17. According to documents obtained under the US's Freedom of Information Act, the constant clatter of equipment aboard Russian-built station modules could disrupt work and sleep–and perhaps even damage astronauts' hearing. In parts of the first element of the station, known as Zarya, already in orbit, astronauts could be subjected to noise level of 72.5 dB(A). In the Russian service module, which will serve as the astronauts' living quarters, officials estimate noise levels as high as 74 dB(A).

ACOUSTICAL·SOCIETY·OF·AMERICA
500 Sunnyside Blvd.
Woodbury, New York 11797