

# Allan D. Pierce : A Celebration of a Career in Acoustics in Commemoration of His Retirement as Editor-in- Chief of the Acoustical Society of America

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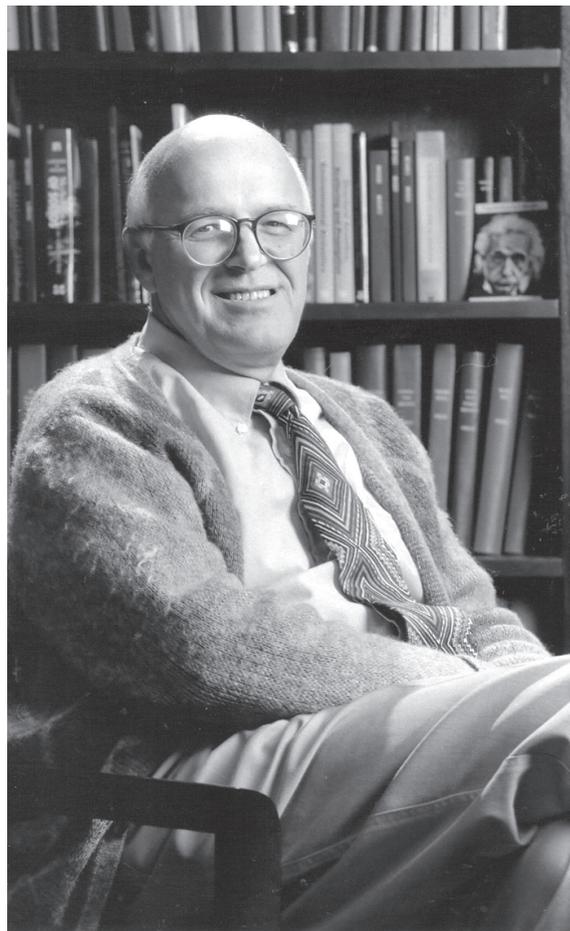
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*The Story of Allan D. Pierce*



*Figure 1. Allan Pierce in 2001 in his office at Boston University.*

Is anyone now active in the Acoustical Society more widely recognized than Allan Pierce (**Figure 1**)? A different way of posing this question is to ask if there is any facet of the Society in which he has not been active? Yet another way of asking this question is to wonder if anyone is unfamiliar with some aspect of Allan's contributions to research and education in acoustics? We have been honored to know him for 35 years and have been in awe all this time with the breadth and depth of his knowledge. An anecdote coming from the era when we were colleagues at Georgia Tech shows that we are not alone in this regard. One year, we were on the examining committee for the PhD qualifying exam for acoustics. One student did exceptionally well during the oral portion of the exam. As he had also done well on the writ-

ten exam, we decided to probe a little more deeply. Allan asked him to name the most famous acoustician ever. Anyone who knows Allan knows that what he was looking for was an indication that the student was aware of the history of acoustics and that the answer that would most satisfy him would be ... Rayleigh. If the student knew Rayleigh's full name and title, that would be even better. On being asked this question, the student's visage changed. One could see his eyes blinking and rolling in panic. After thinking in silence for approximately 30 seconds, the student came up with a reply that was not what Allan expected, but he was prepared to accept. The student replied "You!"

It might surprise the reader to learn that Allan Pierce had no formal education in acoustics. After spending his teenage years in Las Cruces, NM, he attended New Mexico State University where he studied physics. He chose to do his graduate work at MIT. His PhD thesis, entitled *Electron-Lattice Interaction and the Generalized Born-Oppenheimer Approximation* (Pierce, 1962a), fell into the area of quantum mechanics. It was done under the guidance of the famous Hungarian-born physicist, Laszlo Tisza, who had worked with the 1962 Physics Nobel Prize winner, Lev Landau. Allan completed his thesis work in 1961 but even now does not speak highly of his experiences in that period. At an autobiographical seminar given by Allan at Woods Hole Oceanographic Institution (WHOI, 2013), he remarked that he was "not very proud of my thesis." This sent us scampering to the MIT website to find his thesis. What we found was a very scholarly 278-page tour de force filled with nasty foot-long equations bristling with subscripts, superscripts, overbars, and double overbars. A striking aspect is the absence of a comparison with any sort of data or even any computed results. The thesis led to no publications and no citations. It would have been totally forgotten, but as we shall see, solid-state physics' loss turned out to be a bonanza for acoustics.

After MIT, Allan went to work for the RAND Corporation, a renowned think tank stocked with high-powered physicists and mathematicians. It was there that he began his career in acoustics. As low man on the totem pole, he was assigned a problem with little allure for senior members of the staff, who were immersed in nuclear physics and quantum mechanics. He was requested to study the propagation of infrasound (very low frequency signals) generated by an H-bomb. This assignment set the course for his future career. Allan's first openly published work was an abstract for the ASA Meeting in Seattle, WA, in November 1962 in which he discussed a simple acoustical waveguide problem (Pierce, 1962b). The abstract, which appeared while he worked at RAND, is most notable for the fact that it marks the beginning of an important body of work on waveguide propagation that continued throughout his career.

Allan's first journal article, published in the *Journal of the Acoustical Society of America* (JASA) in 1963, was based on his RAND work on infrasound from H-bombs (Pierce, 1963). [To view article visit: <http://goo.gl/hf2JLO> ]. Such waves, which can also be generated by volcanic explosions and other extreme occurrences, such as the Tunguska meteorite event in 1908 or the recent (2013) Chelyabinsk event, propagate over extremely long distances, sometimes propa-

gating several times around the earth. These waves occur at extremely low frequencies (less than 0.01 Hz). They are generally referred to as acoustic gravity waves because the role of gravity at very low frequencies is comparable to the effects of inertia and compressibility of air. Allan has published many papers on acoustic gravity waves, beginning with two JASA papers within the first three years of his efforts at RAND.

After two years in the rarified atmosphere of the RAND Corporation, Allan returned to Massachusetts to work for AVCO. While at AVCO, Allan published his second journal article in JASA, entitled *Extension of the Method of Normal Modes to Sound Propagation in an Almost-Stratified Medium* (Pierce, 1965). This paper, which appeared in January 1965, is probably his most famous and important. It concerns propagation in a waveguide, which is a medium whose boundaries limit the direction in which waves may propagate. Waveguides occur ubiquitously in shallow water and atmospheric acoustics as well as in ducts and pipes. The most simple, common, and instructive way to analyze waveguide propagation is by using normal modes, which are mathematical building blocks for constructing the field. The virtue of using them as the basis for an analysis is that they may be analyzed independently of each other, i.e., they are uncoupled. Normal modes strictly apply only to vertically stratified media, which usually is an excellent approximation for the ocean and atmosphere. However, there are many important situations where the medium changes gradually in the horizontal direction, e.g., near the coasts of oceans where the water depth changes with range. The analysis in this case becomes difficult because a description in terms of normal modes does not lead to uncoupled equations. Allan's landmark paper describes, and mathematically justifies, what has come to be known as "adiabatic normal modes," wherein the computationally intensive modal coupling is ignored and individual modes adapt to the changing environment in an adiabatic manner. As an indication of the significance of this work, we note that it has been cited 34 times within the past 4 years, nearly 50 years after its publication. This is the point where Pierce's thesis is reincarnated. The Born-Oppenheimer approximation, which Pierce employed for his PhD thesis with little impact in solid-state physics, was applied to acoustic problems with great success and wide applicability.

In 1966, Allan morphed into a mechanical engineer and joined the mechanical engineering faculty at MIT. He would remain in academia for the rest of his career, first at MIT un-

til 1973, then at Georgia Tech until 1988, followed by Penn State University until 1993, and finally at Boston University, from which he retired in 2012. His MIT days saw him teaching many of the fundamental courses in mechanical engineering. Given his newness to the area, this must have required considerable effort, but it did not deter him from expanding his research activities in acoustics. An extraordinary piece of work done with Joe Posey was reported in *Nature* in 1971 (Posey and Pierce, 1971). The article explained how the yield of an explosion could be determined by the examination of simple characteristics of the infrasonic waveform measured by a microbarograph without knowing the specific parameters of the atmosphere. The *Nature* article gave a simple formula and a graph showing good agreement between actual and calculated yield. Allan has stated that the US government did not care that the paper gave the yield of weapons in tests done by the USSR, but they were very perturbed that it provided information about US tests.

Another area of acoustics to which Allan contributed extensively was sonic booms. Most notably, he was the first to explain the N-wave spikes and changes in rise time that often appeared in sonic boom waveforms. He determined that they were due to focusing and defocusing by atmospheric turbulence. He wrote many other articles and reports on the subject, including two references cited by Rogers and Maglieri in their article contained in this issue of *Acoustics Today*.

More recently, Allan Pierce published a number of papers with Bill Carey on the properties of acoustic sediments, especially the frequency dependence of the plane wave attenuation coefficient in the low-frequency range (see, e.g., Pierce and Carey, 2010). This parameter is an important factor in shallow-water acoustics because sound propagation always involves strong interaction with the bottom. This is a controversial subject. Conventional wisdom says that the plane-wave attenuation coefficient is proportional to frequency. Recent measurements conflict with this assertion. Working backward from the measured data led to identification of the effect as being proportional to the 1.8 power of frequency. Pierce and Carey showed that it should be proportional to the square of frequency, which is close to the measurements, and that the difference is due to the effects of shear in the sediment.

These are only a few of the diverse areas of acoustics in which Allan Pierce has worked. Together with Yves Berthelot, Allan was among the first to examine how a laser beam moving

supersonically across the surface of the ocean could generate sound within the ocean (Pierce and Berthelot, 1988). In structural acoustics, Allan worked with Jerry Ginsberg to develop simplified semianalytical tools for modeling the acoustic interaction of a submerged vibrating structure. Such problems are extraordinarily demanding from a computation perspective because small details of the structure can have a profound impact on the acoustic field that is radiated or scattered. This feature led Allan to explore the concept and implications of "fuzzy structure" theory. This is a way of representing, in a statistical manner, the multitude of details in a complicated and poorly understood structure like a submarine. His work on this subject with David Feit and Vic Sparrow greatly influenced the direction of research.

Most recently, Pierce and his student Amadou Thiam have been studying energy harvesting from ocean gravity waves, which resulted in a presentation at a session on Energy Harvesting at the San Diego ASA meeting in 2011. As if these efforts were not sufficiently prodigious, Allan's published works also contributed to understanding of many other areas of acoustics, including diffraction along the ground and around obstacles. Not even bioacoustics escaped his attention, as evidenced by his paper on how a cicada, despite its small size, can make so much noise (Hughes et al., 2014).

A hint of Allan's ultimate devotion to ASA may be found in an aspect the reader might already have observed. Nearly all of the papers mentioned thus far were published in *JASA*. Indeed, the overwhelming majority of Allan's work has been published in *JASA*. Although Allan has enhanced the reputation and recognition of *JASA* in many ways, there is little doubt that one of the most significant is Allan's selection of *JASA* as the venue for his papers.

Beyond his research, it is not obvious what aspect of acoustics was most widely impacted by Allan Pierce. It might be education. Probably the greatest influence he has had in this arena is his book *Acoustics: An Introduction to Its Physical Principles and Applications* (Pierce, 1989) originally published in 1981.

It is simultaneously a textbook, a monograph, an encyclopedia, a literature survey, and a history book. It was the only one that we ever thought to use as a textbook when we taught graduate-level acoustics while we were active at Georgia Tech. We cannot say that most students were happy about our choice because the book's objective is to raise a student's expertise to a high level. We told our students on



**Figure 2.** *Synchronized boredom: Allan Pierce (left) and article author Jerry Ginsberg at the plenary session at the spring 2005 ASA meeting on May 18, 2005, in Vancouver, BC, Canada.*

more than one occasion that if we were successful as their instructor, at the end of the two-course sequence they would hold the book in the same high regard that we do (or at least be able to read it!). Allan's philosophy in writing his book is summarized by a clause in the first page of its preface, "...a deep understanding of acoustics is not acquired by superficial efforts." This philosophy led to a book that we were equally comfortable using as a text and a reference work. Whenever we wished to explore an unfamiliar area, Pierce's *Acoustics* was the place where we began. There one can find the key analytical steps, usually accompanied by a thorough list of references to the primary works on the topic and often a chronology of how the topic developed. Even now, 35 years after it was first published, this textbook is the most popular in the ASA books program and, most likely, in the world.

Allan Pierce has affected education in acoustics in many other ways, some of which surprised the authors. He almost is the Johnny Appleseed of acoustics. No one is more responsible than he for the growth of the acoustics programs at Georgia Tech and Boston University, and he greatly strengthened the program at Penn State University. The most remarkable aspect is the manner in which he advanced the cause of acoustics at these institutions. He did not follow the classic approach of an administrator trying to lead his flock. Rather, he recruited and mentored young people for faculty and graduate student positions and worked jointly with many to pursue research objectives. The researchers around the world who have benefited from these interactions are too numerous to list here, but we certainly consider ourselves to be in that group.

We know Allan best as a colleague during his years at Georgia Tech. As we have said, the growth of its program in acoustics is very much the result of Allan's efforts. Indeed,

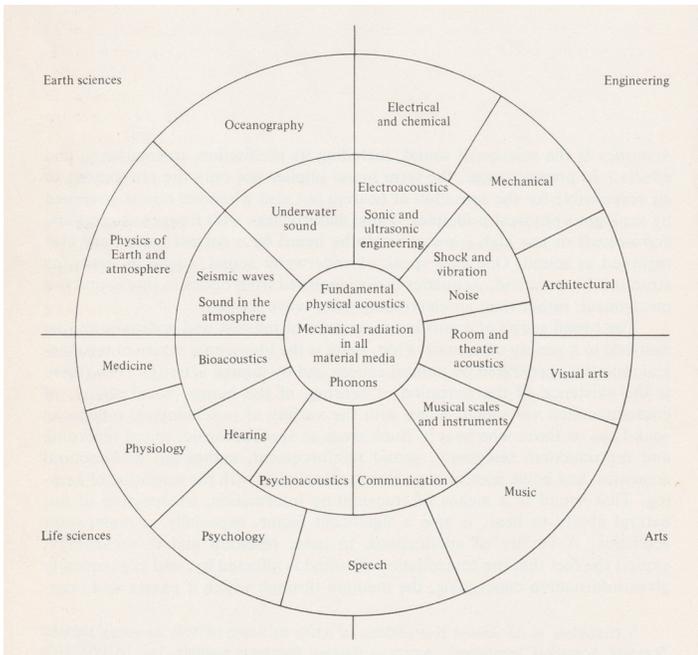
he was the primary force for our recruitment. One of the authors, Jerry Ginsberg, first met Allan when he interviewed at Georgia Tech in 1980. Allan was on sabbatical that year but visited Georgia Tech to participate in the interview. His enthusiasm for the subject captivated Ginsberg. The institution was not highly regarded at that time, but the prospect of working with Allan was an important factor in Ginsberg's decision to move there. On Allan's return from sabbatical, he went to work building the program by expanding its research scope and grabbing all available resources.

In the mid-1980s, a newly appointed Chair of the School of Mechanical Engineering initiated a drive to raise the number and qualifications of the faculty without regard for technical area. As an incentive, the Chair announced that he would give an IBM PC, which was a highly valued commodity at that time, to the faculty member who first contacted an individual who was ultimately hired. Allan came to attention at this announcement like a cat watching a mouse parade. His first objective was recruitment of the other author of this article, Peter Rogers. He too fell under Allan's spell. However, this achievement was not sufficient. At every ASA meeting, it seemed that whatever spare time Allan Pierce had was devoted to talking to talented graduate students and faculty with the objective of interesting them in mechanical engineering at Georgia Tech. By the time the recruitment drive ended, Allan should have had three IBM PCs. However, the Chair reneged with the remarkable assertion that no one could possibly need more than two PCs.

Allan departed from Georgia Tech to become the Leonhard Chair at Penn State University. This allowed him to expand his influence. He mentored several young faculty and collaborated with them on a number of topics, of which the concept of a fuzzy structure received much attention.

However, even back in the days at Georgia Tech, Allan and his wife Penny retained ownership of the home in Wellfleet on Cape Cod that they had acquired just after Allan left MIT. Penny is a Boston girl by birth and inclination. She visited their Wellfleet home whenever possible and never lost a yearning to live there once again. After one too many cold winters out of view of the ocean, they satisfied this desire. Allan and Penny took up residence in Wellfleet when Allan became the Chair of the Department of Aerospace and Mechanical Engineering at Boston University. Allan regularly traveled to Boston to perform his academic duties. The commute was tough, but so is he.

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**Figure 3.** Figure 1-1 from Allan Pierce's *Acoustics* (Pierce, 1989, p. 2) "illustrating the scope and ramifications of acoustics." Adapted from Lindsay, R. B. (1964). *Journal of the Acoustical Society of America* 36, 2242.

As a department chair, Allan had much freedom to pursue his objectives. He administered the Department of Aeronautics and Mechanical Engineering, but his actions suggested that it should have been called the Department of Acoustics. Allan recruited several faculty, made many resources available to current faculty working in acoustics, and enticed faculty in other areas to devote their efforts to acoustics research. By the time he stepped down as chair, the program he administered had become a center of excellence.

The organization that arguably has gained the most from Allan's efforts is the Acoustical Society of America. His work as ASA Editor-in-Chief is the most evident manifestation of his contributions but let us first consider the many other ways that he has advanced the cause of the Society. Sometimes at the biannual ASA meetings, we had the feeling that Allan disproves the statement that a person cannot be in two places at once. You might see him presenting a paper, then at a committee meeting, then out in the hallway taking up a scientific issue with an experienced attendee or a student, dealing with an author in his role as Editor, just being a good friend to an innumerable set of friends, or in a meeting of one of the several technical committees in which he is active. Despite these activities, he somehow manages to attend

the presentations of others. Remarkably, it is not often that we have seen him doze off at these presentations (Figure 2), which is a testimonial to his great interest in anything that fits into Lindsay's rings of the universe, which place acoustics at the center of all of science (Figure 3)!

It is reasonable to deduce that Allan's involvement in the affairs of ASA were extensive. For anyone else, this might have led to a somewhat superficial contribution in a specific activity but not for him. If Allan was in the room, you could be sure that he would have input and that input would drive the activity. This was true for the Tutorials Lectures program, which takes place on the first evening of each ASA meeting, and it continues to be true for the committees in which he is active, notably the technical committees on Physical Acoustics and on Structural Acoustics and Vibrations and the Books+ Committee. If you need to know what topics would be good candidates for a special session, ask Allan. If you need to know who would be a good speaker for a distinguished lecture, ask Allan. If you want a critique of a book published many years ago or a suggestion of good books on acoustics that have been overlooked, ask Allan. If you need a volunteer, ask Allan. Many years ago, we tried to remind Allan that he could decline such requests because the former First Lady Nancy Reagan said that one should "Just say no." Our effort was unsuccessful because Allan's reflex is to "Just say yes" to all things acoustics.

Many individuals know Allan Pierce best in his role as Editor of the *Journal of the Acoustical Society of America*, a role that he took over in 1999. He held this position concurrently with his faculty position as a Professor at Boston University until 2012 when he retired from the University. He retired from the editorship in November 2014. Allan is only the sixth editor of the *Journal* since the Society was formed in 1929. His contributions have been profound. He led its modernization, which made it available online and on CD-ROM. The inception of *JASA-Express Letters*, which allows for the rapid dissemination of current research, came during his tenure. He led the effort to create *Proceedings of Meetings on Acoustics* (POMA) because he believed that the presentations at the Society's meetings were too important to be represented only by an abstract. *Acoustics Today*, which is a separate publication not managed by the editor-in-chief, was expanded as a result of his desire to improve awareness within the Society's membership and the general public of the extensive activities in acoustics.

Modernization of manuscript submission and review procedures also came under Allan Pierce's stewardship. To improve coordination in all aspects of the publication process, he initiated an effort that led to the creation of an editorial office on Cape Cod. The site was chosen for its proximity to his home. This change was beneficial, in that it allowed Allan to more closely monitor activity, but it lessened his separation from the job. The breadth of his dedication is evidenced by the fact that when Allan realized that the prior warehousing arrangement for ASA publications was a large expense, he led the effort to collocate that activity with the editorial office.

Perhaps the greatest impact of Allan's efforts for authors was the online submission process under the PeerXpress system. He instigated significant modifications of the commercially available package to meet his criteria for user friendliness and relevance to the specific needs of the *Journal*. For the associate editors, he took great pains to ensure that the system would assist in the identification of suitable reviewers and also remind them at regular intervals to expedite the review process. For authors, the system made it easier to monitor the status of the review process. Remarkably, given the effort required to develop this system for managing manuscripts, it did not deter Allan from initiating a transition to the latest system. For Allan, any possible improvement in the *Journal* was worthy of his attention.

From an editorial viewpoint, Allan's main objective was to raise the quality of the *Journal*. The measure of his success is the extraordinary level of the papers in every issue. One of his methods to achieve this objective was to greatly enhance the number of associate editors in all areas. His notion was that highly accomplished, successful people would be reluctant to take on such a responsibility if it meant being inundated by a large number of papers to manage. Increasing the number of associate editors reduced the effort, so few individuals refused when requested to serve. Once the associate editors came on board, he turned them loose. All were asked to insert themselves into the review process. That is, reviewers were to be treated as advisors, and the associate editors were decision makers. At the same time, he invited the associate editors to bring him into the loop whenever a thorny issue arose. He even took on the responsibility of serving as an associate editor whenever a submitted paper fell into a



**Figure 4.** Allan Pierce delivering his acceptance speech on receiving the Acoustical Society's Gold Medal at the Vancouver ASA meeting in 2005.

gap where no associate editor felt qualified. Is there anyone else now active in the ASA who could review a paper almost anywhere in the enormous range of areas that fall under the aegis of the *Journal*?

Somehow, despite his involvement in so many research projects, graduate students, teaching, and service, Allan has never neglected his family. Penny, his wife for more years than our combined number of fingers and toes, and he are constant companions at our meetings. Penny is very proud of Allan and is always glad to talk about him. Now that Allan has retired, they are truly enjoying the ambience of Cape Cod. (It seems to the authors that their high regard for the Cape in the winter is misplaced, especially after a strong nor'easter. However, they would say the same to us in the middle of a summer in Atlanta.) Allan and Penny have two children, Brad and Jennifer, both of whom live in a reasonably close range of their home, and they have one grandson, Tristan. Neither Brad nor Jennifer has a career in science or engineering, but there are signs that we might see Tristan at a future ASA meeting.

If the Acoustical Society had any awards for a senior member that Allan Pierce has not received, he would be the leading candidate. He already has received the Silver Medal in Physical Acoustics, the Rossing Prize for Education in Acoustics, and the Gold Medal (see **Figure 4**). None are left, so the best award we can think of would be if you would thank him for his contributions when you see him.

**Biosketches**



**Jerry Ginsberg** received his doctorate in 1969 from Columbia University and joined the faculty of Purdue University. He spent the 1975-1976 academic year as a Fulbright-Hayes Advanced Research Fellow at the ENSEM in Nancy, France. In 1980, he joined the faculty of the Georgia Institute of Technology as Professor, and was awarded the G. W. Woodruff Chair 1989. He retired in 2008. His awards include the Georgia Tech Professor of the Year in 1994, the ASA Trent-Crede Medal in 2005, the ASME Per Brüel Gold Medal in 2007, and the ASA Rossing Prize in Acoustics Education in 2010.



**Peter H Rogers**, pictured with his wife, Alice, received an SB in physics from MIT in 1965 and a PhD from Brown 1970. He worked at the Naval Research Laboratory as a Research Physicist and at ONR as Scientific Officer for Underwater Acoustics before joining the School of Mechanical Engineering at Georgia Tech in 1983. He knew nothing whatsoever about Georgia Tech at the time except that Allan Pierce was there. That was more than enough. He became the Rae & Frank H.

Neely Chair in 1993. He is a fellow of the Acoustical Society of America and recipient of the Biennial Award in 1980.

**References**

Hughes, D., Pierce, A. D., Katz, R. A., and Koch, R. M. (2014). Numerical simulation of sound generation by cicada. *Journal of the Acoustical Society of America* 135, 2266.

Pierce, A. D. (1962a). *Electron-Lattice Interaction and the Generalized Born-Oppenheimer Approximation*. PhD Thesis, Massachusetts Institute of Technology, Cambridge. Available at <http://hdl.handle.net/1721.1/11435>.

Pierce, A. D. (1962b). Sound propagation in a triple-layered medium. *Journal of the Acoustical Society of America* 34, 1990.

Pierce, A. D. (1963). Propagation of acoustic gravity waves from a small source above the ground in an isothermal atmosphere. *Journal of the Acoustical Society of America* 35, 1798-1807.

Pierce, A. D. (1965). Extension of the method of normal modes to sound propagation in an almost stratified medium. *Journal of the Acoustical Society of America* 37, 19-27.

Pierce, A. D. (1989). *Acoustics: An Introduction to its Physical Principles and Applications*. Acoustical Society of America, Woodbridge, NY.

Pierce, A. D., and Berthelot, Y. H. (1988). Validity of linear acoustics for prediction of waveforms caused by sonically moving laser beams. *Journal of the Acoustical Society of America* 83, 913-920.

Pierce, A. D., and Carey W. M. (2010). Sediment shear as a perturbation in geoacoustic inversions and an explanation of the anomalous frequency dependence of the attenuation. *Proceedings of Meetings on Acoustics* 8, 005001.

Posey, J. W., and Pierce, A. D. (1971). Estimation of nuclear explosion energies from microbarograph records. *Nature* 232, 253.

WHOL. (2013). *Distinguished Colleagues: Allan D. Pierce*. Biographical video, Woods Hole Oceanographic Institution, Woods Hole, MA. Available at <https://www.youtube.com/watch?v=xdPOvOjRGYY&feature=youtu.be>.

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