

## Physical Acoustics

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*Members of the Physical Acoustics Technical Committee have varied interests related to the physics underlying acoustic wave generation, propagation, and detection.*

The Technical Committee on Physical Acoustics (TCPA) of the Acoustical Society of America (ASA) includes scientists and engineers with an interest in the underlying physics of acoustical phenomena. This is a necessarily broad statement. TCPA is rather unique among the other technical committees in ASA in that it is not focused on a particular application or context in which acoustics plays an important role. Instead, what unifies the members of TCPA is more about the approach to answering a particular question. The types of phenomena of interest to the physical acoustics community are fundamental acoustic wave propagation, including transmission, reflection, refraction, interference, diffraction, scattering, absorption, and dispersion of sound. There is also interest in the use of acoustics to study the physical properties of matter and to produce changes in these properties. TCPA currently has about 575 members with a primary interest in physical acoustics with 100–150 typically attending open TCPA meetings.

The specific types of problems that interest the physical acoustics community are incredibly varied. Walking into a random TCPA session, one might hear about acoustics in media as disparate as the upper reaches of the atmosphere to solid-state systems under extreme pressure and the use of tools and techniques appropriate to the entire acoustic spectrum from infrasound to ultrasound. I list a few here just to give a flavor, noting this list is far from exhaustive. For example, some of the topics covered by the TCPA might include propagation in solids, liquids, and gases (homogeneous and inhomogeneous) as well as acoustic coupling between these various states of matter; therapeutic, focused ultrasound in human tissue; the use of acoustic resonances to study critical phenomena in physics; the effect of a nozzle design to reduce the noise produced by a jet engine; use of acoustics to detect buried objects in soils and sands; the interaction of sound with light and other forms of radiation; the use of resonances to enhance or enable chemical reactions; production and long-range propagation of infrasound in the atmosphere; non-linear propagation and shocks; and the use of acoustics to control and manipulate fluid flow on a microscopic scale.

One of the great things about the acoustics community is that it brings together groups of scientists and engineers from a wide range of backgrounds, training, expertise, and interests. TCPA exemplifies this cross-disciplinary nature very well. The TCPA membership list includes people in large research universities and small liberal arts colleges, private industry and the military, and individuals with physics, engineering, and biomedical backgrounds. It should be noted, however, that this breadth is a double-edged sword for ASA. There are whole research communities rooted in acoustics that do not come to ASA meetings, opting instead for more focused conferences. Jet and rocket acoustics, acoustofluidics, photoacoustics, and near-surface geophysical acoustics are a few that come to mind. TCPA has

been making an effort to (re)introduce ASA to some of these communities through the organization of special sessions and extending speaking invitations to prominent researchers.

The breadth of interests in the TCPA community makes it hard to hold out one or two examples of recent work that have been especially impactful. Making this doubly difficult is that particularly important work that falls squarely under the umbrella of physical acoustics is sometimes published in well-respected journals that are not focused on acoustics. An example is a paper that was published in 2013 by a team led by Albert Migliori that used acoustic resonances of a YBCO superconductor sample measured in the vicinity of the superconducting transition (Shekhter, 2013). A careful analysis of the temperature dependence of the resonance shifts helped provide insight into an important fundamental question in superconductor physics. Acoustics was the tool that could tease out this insight when other methods could not.

Another recent paper explained the mechanism by which hurricanes generate infrasound. A proper understanding required a detailed theoretical analysis of the non-linear interaction between ocean surface waves and coupling to the atmosphere. The predicted source region of the hurricane was not the eye but south of the eye (in the northern hemisphere). This prediction was verified using arrays of infrasound sensors placed on the eastern seaboard during hurricane Igor in 2010. This work was published by a team led by Roger Waxler (Blom et al., 2014). Coincidentally, Roger Waxler has coauthored an article with Carrick Talmadge on infrasound associated with tornadoes in this issue of *Acoustics Today* (see page 43).

A rapidly emerging and exciting field is acoustofluidics. Ultrasound can be used to manipulate flow, particle separation, cell, and droplet manipulation in microfluidic systems. Such capabilities are critical for the development of “lab on a chip” technologies, which could revolutionize diagnostics in medicine. Acoustics in tiny fluid channels is a relatively novel environment. While much progress has been made in the past decade, much remains to be done. Acoustical issues that come to the forefront (and perhaps leveraged) in these systems are viscous effects, streaming, non-linear effects, and novel transduction design. Undoubtedly, acoustofluidics will continue to be an exciting field to watch in the coming decade (Huang, 2014; Hahn, 2015).

The TC also plays an integral role in the organization of the Physical Acoustics Summer School (PASS). This is a week-

long, intensive summer experience that brings together about 50 graduate students, mid-career professionals, and senior lecturers in a secluded environment to develop both an appreciation for the breadth of the field and to form personal relationships across generations of practitioners (see information about PASS on page 59 of this issue of *Acoustics Today*). PASS has been offered every other year for the past 25 years, and PASS 2016 planning is well underway. PASS has long depended on the TCPA community as a source for participants, from an early graduate student to a senior Fellow in the ASA with hundreds of publications.

One focus over the past few years has been to improve the communication tools for the TCPA community. As with all TCs, we often come up with fantastic ideas in our bi-annual open meetings, but these often die on the vine in the intervening six months. We hope that providing mechanisms for keeping the conversations going will help turn more of these ideas into accomplishments. Some examples of this effort are a complete overhaul of the TCPA website a few years ago (<http://tcpaasa.org>) and the establishment of a Twitter feed (follow us at <https://twitter.com/asacousticspatc>). We have also been involved in modernizing email list management, helping ASA with a pilot project to live stream sessions from meetings to those who cannot physically attend and to create on-line document sharing. All TCs in the ASA have an interest in recruiting and keeping up-and-coming talent. It is our hope that these technologies will help keep the lines of communication open during that dynamic early career phase.

Finally, I describe the culture of the TCPA, and by extension, the ASA as a whole. Many of us have experience with other societies and professional organizations, likely ones more targeted to our specific research areas. And, yet, many of us keep coming back, twice a year, to see our friends and colleagues and hear what they have been working on. One of the reasons ASA fosters such loyalty is the welcoming and supportive culture. This is apparent during TCPA Open Meetings and sessions. Graduate students are supported, not skewered, when they make a mistake in a talk. Disagreements on a particular bit of science or course of action are handled with respect and a desire to understand the point of view of the other, sharing a laugh over a beer is as important as sharing a new result. These relationships lead to partnerships, partnerships lead to more impactful results, and impactful results push the field forward.

## Biosketch



**Dr. Joseph Gladden** is Director of the National Center for Physical Acoustics, Group Leader for the Resonant Ultrasound Spectroscopy lab, an Associate Professor of Physics at the University of Mississippi (UM), and recently added the role of Associate Vice Chancellor of Research for UM. He holds a PhD in Physics from the Pennsylvania State University (2003) with a focus area of Experimental Condensed Matter. His current research interests are critical phenomena, soft matter physics, and structural health monitoring.

## References

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## NEWS from the Acoustical Society Foundation Fund

For over 25 years, the ASA has supported student travel to meetings with grants to help defray travel expenses, most recently through the Acoustical Society Foundation Fund. Student participation at the meetings is consistently around 30% of the total registration—a welcome contribution to the spirited vitality and intellectual rigor of the meetings. Travel grants are awarded to every student applicant who applies, although the amount varies depending on the total number of applicants.

Over the last six meetings, the Foundation has dispersed over \$85,000 in 326 grants to 472 students. For example, 94 students received travel assistance grants for travel to San Francisco in 2013, 98 to Pittsburgh 2015, and 81 to the recent Jacksonville meeting.

The Student Travel Grants program is administered by ASA's Treasurer David Feit, who says: "This is one of the most effective and appreciated programs of the Foundation because it supports the next generation of acousticians and strengthens our Society."

The program began in 1987 spurred by a suggestion from Bob Beyer, Treasurer at the time, and modeled after a starter program from the Georgia Chapter that covered expenses for a single carload of graduate students to attend the meeting in Nashville. Now, your gift to the Foundation can continue to expand the travel grants program and allow it to grow.

**Carl Rosenberg**  
*Chair, Acoustical Society Foundation Board*

### *Mission of the Acoustical Society Foundation Board:*

*To support the mission of the ASA by developing financial resources for strategic initiatives and special purposes.*

**ASFF** For more information, contact: Carl Rosenberg at [crosenberg@acentech.com](mailto:crosenberg@acentech.com)