

**Tyrone M. Porter**  
Assistant Professor  
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**Education:**

University of Washington

Department of Bioengineering, Ph.D., 2003

Dissertation: An investigation of the synergy between ultrasound and membrane disruptive polymers and its effect on cell membranes

Advisor: Lawrence A. Crum (Helmholtz-Rayleigh Medalist, Acoustical Society of America)

Prairie View A&M University

Department of Electrical Engineering, B.S. with honors, 1996

**Research Interests:**

1. Development of targeted ultrasound contrast agents for image enhancement (molecular imaging), perfusion imaging, and image-guided drug delivery
2. Development of ultrasound-triggerable carriers for localized delivery of drugs, DNA, and siRNA to cells and tissue
3. Ultrasound-enhanced drug activity (*i.e.* chemotherapy, thrombolytics)
4. Tissue response to acousto-mechanical forces (apoptosis, wound healing, gene expression, etc.)

**Professional Experience:**

Assistant Professor, Department of Mechanical Engineering, Boston University, 2003 –

Assistant Professor, Department of Biomedical Engineering, Boston University, 2003 –

Postdoctoral Fellow, Department of Biomedical Engineering, University of Cincinnati (2003 - 2006)

Research Projects:

1. Characterization of echogenicity, attenuation, and destruction of echogenic liposomes as a function of frequency
2. Visualization of thrombi (internal blood clots) with targeted echogenic liposomes for diagnosis of occlusions of coronary arteries
3. Release of drugs and macromolecules from echogenic liposomes using ultrasound

Research Assistant, Applied Physics Laboratory, University of Washington (1996-2003)

Research Projects:

1. Disrupting red blood cell membranes with focused ultrasound and pH-sensitive polymers (collaboration with Allan Hoffman (NAE) and Patrick Stayton)
2. Studying platelet aggregation stimulated by focused ultrasound
3. Using ultrasound to disrupt self-assembled monolayers on films loaded with drugs (collaboration with Buddy Ratner (NAE))

Visiting Lecturer, Seattle University, Department of Diagnostic Ultrasound (1999, 2000)

### **Honors and Awards/Fellowships:**

- The National Association of Negro Business and Professional Women's Club Educator of the Year (2010)
- Acoustical Society of America R. Bruce Lindsay Award for "contributions to ultrasound-guided drug delivery" (2008)
- NIH/NINDS R01-NS47603-01S1 - NIH/NINDS Research Supplement for Underrepresented Minorities (Postdoctoral Support) (2005)
- Acoustical Society of America Frederick V. Hunt Postdoctoral Fellow (2003)
- National Society of Black Engineers Graduate Student of the Year (2002)
- UNCF/Merck Predoctoral Fellow (2000-2002)
- Recognized in book **Face Forward: African American Males at a Critical Age**; author, Julian Okwu (1997)
- National Science Foundation Graduate Fellow (1996-1999)
- USA Today Collegiate Academic All-American First Team (1996)

### **Publications:**

#### ***Published or accepted***

- Gong Y, Cabodi M, Porter TM. **Relationship between size and frequency-dependent attenuation of monodisperse populations of lipid-coated microbubbles**, accepted for publication in *Bubble Science, Engineering, and Technology* Nov. 2010.
- Gong Y, Cabodi M, Porter TM. **Pressure-dependent resonance frequency for lipid-coated microbubbles at low acoustic pressures**, *Proceedings IEEE Eng Med Biol Soc. (2010)*, in press.
- Zhang P, Porter T. **An *in vitro* study of a phase-shift nanoemulsion: a potential nucleation agent for bubble-enhanced HIFU tumor ablation**, *Ultrasound Med Biol (2010), Vol 36, No. 11, 1856-1866*.
- Ta T, Convertine A, Reyes C, Stayton P, Porter T. **Thermosensitive liposomes modified with poly(N-isopropylacrylamide-co-propylacrylic acid) copolymers for triggered release of Doxorubicin**, *Biomacromolecules (2010), Vol. 11, 1915-1920*. (listed as one of the most accessed articles for the journal)
- Gong Y, Cabodi M, Porter TM. **Measurement of the attenuation coefficient for monodisperse populations of ultrasound contrast agents**, *Proceedings IEEE Eng Med Biol Soc. (2009), 1964-1966*.
- Zhang P, Porter T. **An *in vitro* study of phase-shift nano-emulsion in focused ultrasound surgery: its potential for enhancing ultrasound-mediated hyperthermia**, *Proceedings of the Northeast Bioengineering Conference (2009)*.
- Smith DAB, Porter TM, Martinez J, Huang SL, MacDonald RC, McPherson DD, Holland CK. **Destruction thresholds of echogenic liposomes with clinical diagnostic ultrasound**, *Ultrasound Med Biol (2007), Vol. 33, No. 5, 797-809*.
- Porter TM, Smith DAB, Holland CK. **Acoustic techniques for assessing the Optison® destruction threshold**, *J Ultrasound Med (2006), Vol. 25, No. 12, 1519-1529*.

- Datta S, Coussios CC, McAdory LE, Tan J, **Porter TM**, De Courten-Myers G, Holland CK. Correlation of cavitation with ultrasound enhancement of thrombolysis, *Ultrasound Med Biol* (2006), Vol. 32, Issue 8, 1257-1267.
- Porter TM**, Murthy N, Mourad PD, Stayton PS, Hoffman AS, and Crum LA. Control of cavitation-induced hemolysis with a surface-active polymer, *Acoustics Research Letters Online* (2005), Vol. 6, Issue 3, 201-206.
- Porter TM**, Crum LA, Black F, Stayton PS, and Hoffman AS. The effect of polymer surface activity on cavitation nuclei stability against dissolution, *J Acoust Soc Am* (2004), Vol. 116, No. 2, 721-728.
- Mourad P.D., Murthy N, **Porter T.M.**, Poliachik S.L., Crum L.A., Hoffman A.S., and Stayton P.S., Focused Ultrasound and Poly(2-ethylacrylic acid) Act Synergistically to Disrupt Lipid Bilayers *In Vitro*, *Macromolecules* (2001) Vol. 34, 2400-2401.
- Porter T**, Hadley M, Nickerson J, Mourad P, Crum L, Murthy N, Stayton P, and Hoffman A. Measured bioeffects of tone-burst ultrasound in combination with poly(propyl acrylic) acid (PPAA), *Proceedings of the IEEE Ultrasonics Symposium* (2000), Vol. 2, 1359-1362.
- Poliachik S.L., Chandler W.L., Mourad P.D., Bailey M.R., Bloch S., Cleveland R.O., Kaczkowski P., Keilman G., **Porter T.**, and Crum L.A. Effect of High-Intensity Focused Ultrasound on Whole Blood with and without Microbubble Contrast Agent, *Ultrasound in Med. and Biol.* (1999) Vol. 25, No. 6, 991-993.

### **Submitted**

- Kopechek JA, Haworth KJ, Raymond JL, Perrin SR, Klegerman ME, Huang S, **Porter TM**, Mast TD, McPherson DD, Holland CK. Acoustic characterization of echogenic liposomes: frequency-dependent attenuation and backscatter. *J Acoust Soc Am* Nov 2010.
- Meunier JM, Holland CK, Porter TM, Lindsell CJ, Shaw GJ. Comparison of thrombolytic therapies with ultrasound and plasminogen in an *in vitro* human clot model. *Thrombosis Research* Nov 2010.
- Zhang P, Porter TM. Spatial and temporal control of bubble-enhanced HIFU-mediated heating and lesion formation using vaporized phase-shift nanoemulsions. *J Acoust Soc Am* Dec 2010.
- Gong Y, Cabodi C, Porter TM. Pressure-dependent resonance frequency for monodisperse lipid-coated microbubbles: Effect of diameter and shell composition. *J Acoust Soc Am* Dec 2010.

### **Abstracts**

- Zhang P, **Porter TM**. The relationship between acoustic backscattering and heating during bubble-mediated high intensity focused ultrasound. *J Acoust Soc Am* (2009), Vol. 126, 2176.

- Gong Y, Cabodi M, **Porter TM**. An *in vitro* study of the relationship between size of lipid-coated microbubbles and frequency-dependent attenuation coefficient. *J Acoust Soc Am* (2009), Vol. 126, 2175.
- Kopechek JA, Porter TM, Coussios C-C, Perrin SR, Huang S, McPherson DD, Holland CK. Acoustic characterization of echogenic liposomes: attenuation and quantitative backscatter. *J Acoust Soc Am* (2009), Vol. 125, 2712.
- Pierce AD, Carey WM, **Porter TM**. Card-house theory of mud sediments containing kaolinite and its acoustical implications. *J Acoust Soc Am* (2008), Vol. 124, 2561.
- Porter TM**, Zhang P. Temperature and size-dependence of the vaporization threshold of phase-shift emulsions, *J Acoust Soc Am* (2008), Vol. 123, 2997.
- Shaw GJ, **Porter TM**, Meunier JM, Woo D, Holland CK. **Low-intensity 120-kHz pulsed ultrasound “busts” more clot” than 2 MHz transcranial Doppler ultrasound in the presence of rt-PA.** *Stroke* (2007) Vol. 38, No. 2, 509.
- Porter TM**, Holland CK, Meunier JM, Shaw GJ. Enhancement of recombinant tissue-plasminogen activator (rt-PA) with 2-MHz transcranial Doppler ultrasound. *J Acoust Soc Am* (2006), Vol. 120, No. 5, 3004.
- Smith DA, **Porter TM**, Holland CK, Huang S, MacDonald RC, McPherson DD. Destruction thresholds of echogenic liposomes with clinical diagnostic ultrasound. *J Ultrasound Med*, (2006) Vol. 25, S12.
- C. K. Holland, **T. M. Porter**, D. D. McPherson. Ultrasound-assisted drug delivery and thrombolysis, *Ultrasound Med. Biol*, (2006) 32:P45.
- Porter TM**, Smith DAB, Holland CK. **Quantification of the pressure threshold for Optison® destruction,** *J Ultrasound Med* (2006), Vol. 25, S12.
- Porter TM**, Vaidya SS, Holland CK, Huang SL, MacDonald RC, McPherson DD. (2005) Evaluation of backscattered intensity to quantify the destruction rate of echogenic liposomes, *J Acoust Soc Am* (2005), Vol. 117, 2531.
- Smith DAB, **Porter TM**, Holland CK, Huang SL, MacDonald RC, McPherson DD. Effect of clinical diagnostic ultrasound pressure amplitude and pulse repetition frequency on echogenic liposome destruction. *J Acoust Soc Am* (2005), Vol. 117, 2557.
- Porter TM**, Holland CK, Datta S, Huang SL, MacDonald RC, McPherson DD. *In vitro* characterization of echogenic liposomes by acoustic scattering at 3.5-15.0 MHz, *J Acoust Soc Am* (2004), Vol. 115, 2560.

#### Patents:

- Hoffman AS, Stayton PS, Press OW, Tirrell D, Murthy N, Lackey C, Crum LA, Mourad PD, **Porter TM**. **Enhanced Transport Using Membrane Disruptive Agents.** Patent No. U.S. 6,835,393 (issued 12/28/2004).

#### Invited Talks

- Measurement of the attenuation coefficient of monodisperse populations of ultrasound contrast agent.** 31<sup>st</sup> Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Minneapolis, MN September 2-6, 2009.

**Engineering nanoparticles for localized noninvasive cancer therapy.** Department of Hematology and Oncology, Boston University. April 23, 2009.

**Harnessing the power of bubbles in biomedical ultrasound.** Department of Physics, Ryerson University, Toronto, Ontario Canada. March 19, 2009.

**Biomedical ultrasound.** 34<sup>th</sup> National Convention for the National Society of Black Engineers, Orlando, FL, March 19-23, 2008.

**Medical acoustics: Diagnostic and therapeutic applications of ultrasound.** Joint Meeting of the National Society of Black Physicists and the National Society of Hispanic Physicists, Washington, D.C., February 21, 2008.

**The role of chemistry in medical applications of ultrasound.** UNCF/Merck Fellows Day, Whitehouse Station, NJ, June 25, 2007

### **Presentations**

**Porter TM, Vaidya SS, Holland CK, Huang SL, MacDonald RC, McPherson DD. (2005) Evaluation of backscattered intensity to quantify the destruction rate of echogenic liposomes** (oral) 149<sup>th</sup> Meeting of The Acoustical Society of America joint meeting with the Canadian Acoustical Association, Vancouver, British Columbia, May 16-20.

**Porter TM, Holland CK, Huang S, McDonald RC, McPherson DD. (2004) *In vitro* characterization of echogenic liposomes by acoustic scattering at 3.5 to 15.0 MHz** (oral), 147<sup>th</sup> Meeting of The Acoustical Society of America, New York, NY, May 24-28.

**Porter TM, Black F, Hoffman AS, Stayton PS, Crum LA. (2002) Evaluation of polymer solubility and cavitation on ultrasound polymer synergy** (oral), Joint Session: 144<sup>th</sup> Meeting of the Acoustical Society of America, 3<sup>rd</sup> Iberoamerican Congress of Acoustics, and 9<sup>th</sup> Mexican Congress on Acoustics, Cancun, Mexico, December 2-6.

**Porter TM, Murthy N, Hoffman AS, Stayton PS, Crum LA. (2001) Delivery of Macromolecules Using Combination of High Intensity Focused Ultrasound and Membrane Disruptive Polymers** (poster), 17<sup>th</sup> International Congress on Acoustics, Rome, Italy, September 2-7, 2001

**Porter TM, Murthy N, Hoffman AS, Stayton PS, Crum LA. (2001) The Membrane Disrupting Potential of HIFU and pH-Sensitive Poly(propyl acrylic acid) (PPAA)**, Applied Physics Laboratory Seminar Series, Seattle WA.

**Porter TM, Murthy N, Mourad P, Hoffman AS, Stayton PS, Crum LA. (2000) Influence of Chemical Composition of Membrane Disrupting Polymers on Relative Cavitation Activity and Hemolysis** (oral), Joint Session: 140<sup>th</sup> Meeting of the Acoustical Society of America and Annual Meeting of the Institute of Noise Control Engineering, Newport Beach, CA, December 3-8.

**Porter TM, Murthy N, Mourad P, Hoffman AS, Stayton PS, Crum LA. (2000) Synergy Between High Intensity Focused Ultrasound (HIFU) and pH Sensitive Polymers for Disruption of Cell Membranes** (poster): Institute of Electrical and Electronics Engineers International Ultrasonics Symposium, San Juan, Puerto Rico, October 22-25.

**Porter TM, Kwok C, Ratner B, Crum LA. (1999) Enhanced Release of Macromolecules from a Novel Polymeric Film Coated with Self-Healing, Ordered Methylene Chains** (poster). 43<sup>rd</sup> Meeting of the Biophysical Society, New Orleans, LA, February 15-19.

**Porter TM, Mourad P, Murthy N, Poliachik SL, Hoffman AS, Stayton PS, Crum LA. (1998) PEAA/Ultrasound Induced Hemolysis of Erythrocytes** (oral). Joint Session: 135<sup>th</sup> Meeting of the Acoustical Society of America and 16<sup>th</sup> International Congress on Acoustics, Seattle, WA, June 20-26.

#### **Professional Societies:**

- Acoustical Society of America
- Institute of Electronics and Electrical Engineers
- Controlled Release Society
- International Society for Therapeutic Ultrasound
- National Society of Black Engineers
- National Society of Black Physicists
- Tau Beta Pi National Engineering Honor Society
- Eta Kappa Nu National Electrical Engineering Honor Society

#### **Leadership:**

- **Acoustical Society of America**  
**Chair**, Technical Session on “Image-guided therapeutic ultrasound,” 160<sup>th</sup> Meeting, Cancun, Mexico, November 15 – 19, 2010.  
**Chair**, Technical Session on “Microbubble response to acoustic excitation,” 156<sup>th</sup> Meeting, Miami Florida, November 10 – 14, 2008.  
**Co-Chair**, Technical Session on “Therapeutic applications of ultrasound contrast agents, 155<sup>th</sup> Meeting, Paris, France, June 30 – July 4, 2008.  
**Chair**, Topical Meeting on “Tissue response to ultrasound,” 154<sup>th</sup> Meeting, New Orleans, LA, November 27 – December 1, 2007.  
Education Committee, at-large member (2006 - )  
Biomedical Ultrasound/Bioresponse to Vibration Committee, at-large member (2004- )  
Student Council (2002-2003)  
Local Organizing Committee for the Joint Session of the 135<sup>th</sup> Meeting of the Acoustical Society of America and the 16<sup>th</sup> International Congress on Acoustics, Seattle, WA, June 20-26, 1998.
- **National Society of Black Physicists**  
Chair, Technical Session on Acoustics, Nashville, TN, February 10-14, 2009.
- **National Society of Black Engineers**  
Director, Bioengineering Special Interest Group (2006 -2008)
- **Boston Collegiate Charter School**  
Board of Trustees, at-large member (2008 - )

## Teaching Experience

- **Department of Mechanical Engineering, Boston University**  
ME 700: Biomedical Ultrasound (Spring 2010)
  - Develop course curriculum, including homework and projects
  - Lead group discussions on complex concepts and homework
  - Grade examinations and quizzes
- **Department of Mechanical Engineering, Boston University**  
ME 303: Fluid Mechanics (Fall 2009)
  - Develop course curriculum, including homework and projects
  - Lead group discussions on complex concepts and homework
  - Grade examinations and quizzes
- **Department of Aerospace and Mechanical Engineering, Boston University**  
EK 302: Engineering Mechanics II (Fall 2006 – Spring 2009)
  - Develop course curriculum, including homework and projects
  - Lead group discussions on complex concepts and homework
  - Grade examinations and quizzes
- **Department of Biomedical Engineering, University of Cincinnati**  
Career Building Blocks (Winter/Spring 2004; Spring 2005)
  - Contact guest lecturers
  - Assign homework
  - Evaluate and critique students' presentation skills
- **Department of Diagnostic Ultrasound, Seattle University**  
Physics of Ultrasound (2000)
  - Developed lectures, homework problems, and exams
  - Organized field trip to local ultrasound company  
Diagnostic Ultrasound Instrumentation (1999)
  - Developed lectures, homework problems, and exams
  - Organized field trip to local ultrasound company

## Service

### Department of Mechanical Engineering, Boston University

Website Committee: at-large member, 2008 –

Graduate Education Committee: at-large member, 2006 – 2010

## Doctoral Dissertation Committees:

Zhang, X. **Novel cationic amphiphiles for gene delivery**, Department of Biomedical Engineering, Boston University, Degree awarded Fall 2010.

Basarir, O. **Near-field optical probing of nanomechanical systems**, Department of Mechanical Engineering, Degree awarded Fall 2010.

Karabacak, DM. **Resonant operation of nanoelectromechanical systems in fluidic environments**, Department of Aerospace and Mechanical Engineering, Boston University, Degree awarded Summer 2007.

Farny, CH. **Identifying and monitoring the roles of cavitation in heating from high-intensity focused ultrasound**, Department of Aerospace and Mechanical Engineering, Boston University, Degree awarded Fall 2006.

LaManna, CM. **Synthesis and evaluation of photo-active amphiphiles for gene delivery applications**, Department of Biomedical Engineering, Boston University

Valtierra, R. **Development of techniques for underwater acoustic source localization using an autonomous passive acoustic system**, Department of Mechanical Engineering, Boston University

#### **Master's Thesis Committee:**

Lyford, N. **Evaluating vibrotactile title feedback for balance-deficient subjects using waveform-based display coding**, Department of Biomedical Engineering, Boston University, Degree awarded Fall 2008.

#### **Funding**

##### PRIOR

NIH/NINDS R01-NS47603-01S1 - NIH/NINDS Research Supplement for Underrepresented Minorities (Postdoctoral Support) (2005-2006)

Fred V. Hunt Postdoctoral Fellowship, includes salary and research allowance (2003-2004)

“Ultrasound-induced delivery of cancer chemotherapeutic drugs.” co-PI Center for Integration of Medicine & Innovative Technology, \$40,000; 01/01/09-12/31/09.

“Sound speed and attenuation in muddy sediments.” Office of Naval Research, \$166,000; 10/01/06-09/30/11.

“Combination of cationic nanoemulsion and ultrasound for siRNA delivery.” (lead PI) Center for Nanoscience and Nanobiotechnology, \$20,000: 01/01/10-06/30/10.

“A nanoparticle encapsulated photo-sensitizer system for targeting, localizing, imaging, and treating local and metastatic tumor in one platform.” (co-PI) Center for Nanoscience and Nanobiotechnology, \$20,000: 01/01/10-06/30/10.

##### CURRENT

“MRI-guided HIFU-mediated heating and lesion formation enhanced with phase-shift nanoemulsions.” NIH, \$453,180; 07/01/10-06/30/12.

"BRIGE-The role of cavitating perfluorocarbon bubbles in ultrasound-induced heating in tissue-mimicking phantoms." NSF, \$174,987; 09/01/09-08/31/11.

“MRI-guided localized delivery of chemotherapy using temperature-sensitive liposomes and high intensity focused ultrasound.” Focused Ultrasound Surgery Foundation. \$100,000: 01/01/10-12/31/10.

“NUE: Undergraduate Laboratory Experiences in Nanotechnology devices and Systems (U-LENS).” co-PI NSF, \$200,000: 09/01/09-08/31/11.

##### PENDING



“CAREER - Development of polymer-modified liposomes that release chemotherapy locally in response to mild acidity and hyperthermia.” NSF, \$400,000; 02/01/11 – 01/31/16.

“Collaborative Research: Acoustically-driven autoresonance in monodisperse populations of encapsulated microbubbles.” NSF, \$233,920; 05/01/11 – 04/30/14.

“Polymer-modified liposomes for delivery of chemotherapy at low thermal dose.” NIH, \$452,046; 07/01/11 – 06/30/13.

“A novel vitamin D derivative for kidney cancer.” R. Ray lead PI; NIH, \$2,299,402; 7/1/11-6/30/2016.

“A vitamin D derivative for androgen-refractory prostate cancer.” R. Ray lead PI; NIH, \$1,250,000; 7/1/11-6/30/2016.