Physics Colloquium

Michigan Technological University

Thursday, March 26, 2015
4:00 pm
Room 139, Fisher Hall

Dynamic Photoacoustic Spectroscopy for Trace Gas Detection

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Abstract:
Dynamic photoacoustic spectroscopy (DPAS) is a trace-gas sensing technique recently developed at MIT Lincoln Laboratory. It is a novel laser-based means of remotely sensing extremely low concentrations of gases.
The ability to remotely detect trace gases is of great interest for many reasons. It has the potential to enable many important capabilities, including efficient monitoring of environmental pollutants, safe detection of threats from chemical agents or explosives, or monitoring of illegal activities (i.e., drug manufacturing) via effluent detection. In many cases, the relevant vapor concentrations are quite low; thus, a highly sensitive technique is required. No techniques developed to date have demonstrated both high sensitivity and remote operation. DPAS has recently[1,2] demonstrated both the high sensitivity and standoff capability necessary to significantly impact several important missions.
DPAS is a variant of the well-known photoacoustic spectroscopy (PAS). PAS is a laser-based technique that detects gases by generating acoustic signals via a laser tuned to different absorption features of the gas. What separates DPAS from PAS is that the DPAS laser beam is swept through a gas plume at the speed of sound. The resulting coherent addition of acoustic waves leads to an amplification of the acoustic signal. In a manner similar to shock waves generated by supersonic jet planes, a shock wave is produced with significantly enhanced amplitude as compared to the very weak photoacoustic signal. In contrast, PAS generally requires a closed resonant chamber for amplification (inherently not a standoff configuration). Using DPAS, we have generated and detected acoustic signals as high as 83 dB (easily audible to the unaided human ear) from trace gases.

Biography:
Dr. Charles M. Wynn is a technical staff member in the Chemical, Microsystem, and Nanoscale Technologies Group at Lincoln Laboratory. He leads several efforts focused on laser-based trace detection including detection of trace explosives. He is also engaged in research using photoacoustic spectroscopy for chemical detection and has recently begun a biotechnology initiative using a novel photoacoustic sensing approach. Additional research interests include molecular electronics, low-light imaging systems, and microwave spectroscopy of left-handed metamaterials. Prior to joining MIT in 2000, he worked at XonTech, Inc. and Ohio State University, where he studied designer organic magnets. In 2013, he received an R&D 100 Award for his acoustic-based explosives-detection technique. He was an invited speaker at the Military Sensing Symposia in 2009 and 2010. He has two patents (and one pending) related to trace explosives–detection techniques he developed. He has more than 30 scientific publications spanning a diverse range of topics. He earned BS, MS and PhD degrees, all in physics, from the University of Connecticut, Carnegie Mellon University, and Clark University, respectively. His thesis research was in the area of molecular magnetism.

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[1] Wynn et al., Applied Physics Letters, vol. 101, 2012.
[2] Wynn et al., Optical Engineering, vol. 53, no. 2, 2014.