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Michigan Institute for Plasma Science and Engineering

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3:10 pm
Room 1003 EECS

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Multiscale Analysis of the Energetics of a Sonoluminescing Plasma Blackbody: What Are the Limits of Energy Density Concentration that Can Be Achieved with Collapsing Bubbles?

A gas bubble in a fluid can concentrate the energy density of a sound wave by 12 orders of magnitude to create picosecond flashes of light that originate in a dense strongly coupled plasma. An abiding question is: what are the limits of energy focusing that can be realized with sonoluminescence? Our attempt at an answer involves a multi-scale simulation of an imploding bubble. The fluid must be described by compressible fluid mechanics as the velocity of implosion exceeds Mach 1. The gas containing fluid cavity is described by molecular dynamics as the gradients of temperature and velocity can be very steep. The available energy per atom matches the measured emissivity and temperature, provided the ionization energy is much lower than current theories. Application of compressed ultrafast photography to laser breakdown of dense gases reveals a consistent requirement on the large reduction of the ionization potential in these plasmas. Our multiscale analysis allows predictions for regions of parameter space where energy density concentration is substantially larger.

About the Speaker: Seth Putterman is a Professor of Physics at UCLA, and President of the Julian Schwinger Foundation for Physics Research. He received a BS from Caltech and a PhD from Rockefeller University with George E. Uhlenbeck. Putterman's thesis on the macroscopic theory of superfluids was expanded into a monograph. His theoretical research in nonlinear fluid mechanics and acoustics motivated him to set up an experimental lab which probed energy-focusing phenomena such as sonoluminescence, X-ray emission from triboelectrification, and crystal-generated nuclear fusion. Putterman [with Porrati] developed the foundational theory of sequential quantum jumps in a driven system such as intermittency in the fluorescence of a single trapped ion. He has served on the Defense Sciences Research Council. His work on sonoluminescence was featured on BBC2 Horizon, "An Experiment to Save the World". He is a Fellow of the Acoustical Society of America and the American Physical Society and recipient of a Sloan Fellowship. Putterman was named the UCLA 2010–2011 Faculty Research Lecturer. Currently he is PI on a phase 2 clinical trial at UCLA hospital aimed at curing chronic wounds. *Nature* profiled his out of the mainstream approach to science in their October 2005 issue.