

# Seminar Talk

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Friday, April 10, 2015  
3:00 p.m. KH 224

**Title:** Cellular Manipulation by Intense Electromagnetic Radiation

**Abstract:**

Electromagnetism is a well-established phenomenon for sensors; however, one may also use intense electromagnetic radiation, such as pulsed power, plasmas, or lasers, to induce changes in cellular function. Recent investigations have focused on utilizing these technologies to induce multiscale changes in biological specimens for applications ranging from drug delivery to wound treatment. The most common and mature example is electroporation, in which electric pulses of microseconds to milliseconds in duration and a few kilovolts per centimeter in field strength are applied to a tissue or cell suspension to charge the cell membranes to the point at which they open. This facilitates the delivery of molecules normally unable to penetrate the membrane, enabling technologies that include sterilization, gene therapy, and electrochemotherapy. Recent modifications have reduced the pulse duration (10-300 ns) and raised the field strength (30-300 kV/cm) to additionally manipulate intracellular organelles to alter cellular function.

In this talk, I will outline my group's integration of analytic approaches, simulations, and experiments to study phenomenon at the interface between physics, engineering, and life sciences. First, I will briefly summarize the physics, biology, and application space for pulsed power in healthcare. Next, I will outline the contributions of computational physics toward predicting the effects of AC (sinusoidal) fields on membrane pore formation and the generation of cell membrane temperature gradients induced by electric pulses, including speculation on the practical implications of these phenomena. I will also explain how measurements of changes in cellular dielectric properties provide insight into relevant mechanisms and provide information for subsequent computations. I will next discuss ongoing collaborations with GE Global Research Center to develop applications of nanosecond pulsed electric fields for platelet activation and cold atmospheric plasmas for food treatment. I will conclude by summarizing future plans for studying material interactions with pulsed electric fields, plasmas, and lasers.

**Bio:**

Dr. Allen Garner received his BS in nuclear engineering from the University of Illinois in 1996, MSE in nuclear engineering from the University of Michigan in 1997, MS in electrical engineering from Old Dominion University in 2003, and Ph.D. in nuclear engineering from the University of Michigan in 2006. From 1997 to 2003, he served on active duty in the U. S. Navy as a nuclear trained submarine officer, including tours as a division officer onboard the USS Pasadena (SSN 752) and Prospective Nuclear Engineering Officer instructor in Norfolk, VA. From 2006 to 2012, Dr. Garner was an electromagnetic physicist at GE Global Research Center in Niskayuna, NY, where he conducted computational work in electromagnetism, plasmas, and multiphysics and led multidisciplinary efforts in plasma medicine. Since August 2012, he has been an Assistant Professor in Nuclear Engineering at Purdue University and is the Paul C. Zmola Scholar of Nuclear Engineering. He is also a Commander in the United States Navy Reserves presently assigned as the Commanding Officer for the Central South Region of SurgeMain, which provides qualified technicians to support the Navy's Public Shipyards. Dr. Garner is a Senior Member of IEEE and has been awarded the Navy and Marine Corps Commendation Medal and five Navy and Marine Corps Achievement Medals.