AbstractID: 14532 Title: Physics in the Evolution of Contrast Agents in Ultrasound

The acoustic bubble has graduated from an intriguing curiosity in physics to the center stage of ultrasound imaging in clinical medicine. This is principally a consequence of the development of a new generation of bubble constructs - heavy gases stabilized by a shell of lipid or other biocompatible material - that have been approved as intravenous contrast agents for diagnostic medicine. The bubbles are smaller than a red blood cell and so pass freely around the circulation. By a serendipity, they happen to resonate at frequencies within the diagnostic range, and so can be driven easily into nonlinear oscillation by a typical ultrasound imaging pulse. This has spawned a mass of nonlinear echo detection strategies that are now sufficiently sensitive to detect an individual 3 micron bubble flowing in a capillary more than 10 cm below the skin surface, while rejecting echoes from tissue. The resulting real time perfusion images have redefined what is possible to diagnose from a medical ultrasound image. This talk will explore the bubbles and their acoustic behavior, the nonlinear imaging methods to detect them and their applications in medicine. Foremost among these is the ability to detect the microvessels that accompany the growth of a cancer - malignant angiogenesis - and, by disrupting the bubbles remotely using the ultrasound beam, to measure blood flow at the tissue level, an important indicator of response to therapy. In their current form, the bubbles flow in the vascular system without interacting with it, but it is easy to modify their surface so that they bind to specific cellular or molecular targets on the endothelial cells lining blood vessels. Such biomarkers assure ultrasound a place in the effort to create an imaging method of the future that provides functional information about the patient at a molecular, as well as a macroscopic level.