CANDIDATE FOR VSE STRATEGIC HIRE

Date: Tuesday, May 28, 2019
Time: 11:00 am - 12:30pm
Location: Research Hall 163
(Video-Conferencing to Prince Williams, Bull Run Hall, Rm 254)

Peter Basser, Ph.D.

Biography: Peter J. Basser, Ph.D. is a scientist-inventor whose work has transformed how neurological disorders and diseases are diagnosed and treated, and how brain architecture, organization, structure, and anatomical "connectivity" are studied and visualized. He is the principal inventor of Diffusion Tensor Magnetic Resonance Imaging (DTI)—a non-invasive MRI technology that yields a family of novel features and imaging biomarkers. Quantities that he proposed include the mean apparent diffusion coefficient (mADC)—a DTI-derived parameter widely used to follow changes in stroke and cancer, and the fractional anisotropy (FA), a robust quantity that makes brain white matter visible to radiologists and neuroscientists. He also proposed and developed "Streamline Tractography", a means to elaborate white matter pathways, which now helps neuroradiologists plan brain surgeries. More recently, Dr. Basser has been a pioneer in the field of "Microstructure Imaging", which uses MRI data and models of water diffusion in tissue to extract salient micron-scale morphological features. Examples of MRI methods Dr. Basser invented and developed with colleagues include the non-invasive measurement of the mean axon diameter (CHARMED), the axon diameter distribution (AxCaliber), and the mean apparent propagator (MAP) in each voxel. He and members of his lab have also been actively involved in developing multiple pulsed-field gradient (mPFG) methods to measure microscopic diffusion anisotropy, which they reported observing in gray matter as early as 2007. Within the past few years, Dr. Basser's lab has continued to make important contributions in neuroimaging, inventing and developing MRI methods to measure and map joint relaxation and diffusion spectra in brain tissue.

Dr. Basser received his undergraduate and graduate training in Engineering Sciences at Harvard University and his post-doctoral training in the Intramural Research Program (IRP) of the National Institutes of Health in Bethesda, MD. Currently, he is a Principal Investigator and Associate Scientific Director within the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development.

Title: Advances in Quantitative MRI and Tissue Sciences

Abstract: Tissue Sciences is a broad field of inquiry whose adherents strive to understand fundamental relationships between function and structure in living tissues using various quantitative models and methodologies. We are interested in how microstructure, hierarchical organization, composition, and material properties all affect biological function and dysfunction, particularly in neural tissue and extracellular matrix (ECM). We investigate biological and physical model systems, such as, "engineered" tissue constructs, and tissue analogs, at different time and length scales, making physical measurements in tandem with developing mathematical and computational models to design these experiments and interpret their findings. Primarily, we use water molecules to probe both equilibrium and dynamic interactions among tissue constituents over a wide range of time and length scales. We also develop and use physics and engineering principles to understand how observed changes in tissue microstructure and physical properties affect transport of mass, charge, momentum, and magnetization. The most direct noninvasive *in vivo* method for characterizing these essential transport processes in tissues is magnetic resonance imaging (MRI), which we use to follow microstructural changes in development, degeneration, aging, and trauma. A goal of our basic tissue sciences research is to translate our quantitative methodologies and the understanding we glean from them from "bench to bedside."

Our Tissue Sciences activities dovetail with our basic and applied research in Quantitative Imaging, which is intended to generate *in vivo* measurements and maps of intrinsic physical quantities, including magnetization, diffusivity, relaxivity, and exchange rates, rather than qualitative images widely used in radiology. We use knowledge of physics, engineering, applied mathematics, imaging and computer sciences, and insights gleaned from Tissue Sciences research, to discover and develop novel imaging "stains" or "contrasts" that can sensitively and specifically detect changes in tissue composition, microstructure, or microdynamics. Our ultimate goal is to use these as quantitative imaging biomarkers to assess normal and abnormal development, diagnose childhood diseases and disorders, and characterize degeneration and trauma. MRI is our imaging method of choice: it is non-invasive, non-ionizing, generally requires no exogenous contrast agents or dyes, and is deemed safe in both clinical and research settings.

One of our technical objectives has been to turn clinical MRI scanners into quantitative scientific instruments capable of producing reproducible, accurate, and precise imaging data and to be able to measure and map useful imaging biomarkers for pre-clinical and clinical applications, including for single, longitudinal, and multi-center studies, for personalized medicine, and for populating imaging databases with high-quality normative data.