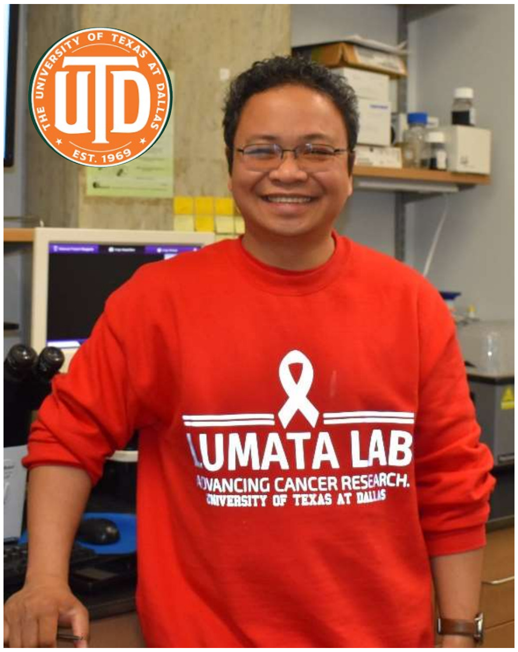

The 12th Annual Exhibition of Undergraduate Research and Creative Activities – EXPO 2025

GUEST SPEAKER

Dr. Lloyd L. Lumata, Ph.D.

Associate Professor of Physics
Department of Physics
Affiliated to Dept. of Neuroscience & Dept. of Bioengineering
University of Texas at Dallas

Live Oak Ballroom of Setzer Center
April 23, 2025 - from **9:15 - 10:00 am**

SHORT BIOGRAPHY:

Lloyd Lumata obtained his BS in Physics at the Western Mindanao State University, Philippines in 2002. He went to graduate school at the National High Magnetic Field Lab in Florida State University (FSU) in 2004 wherein he studied nuclear magnetic resonance (NMR) of organic conductors under the supervision of Prof. James Brooks at the National High Magnetic Field Laboratory. He earned his PhD in Condensed Matter Physics at FSU in 2008. In 2009, he moved to Dallas for a postdoc position at the University of Texas Southwestern Medical Center (UTSW). At UTSW, he assembled an MRI signal-enhancing instrumentation called hyperpolarizer that amplifies the MRI signals by >10,000-fold. This machine was used for high resolution cardiac and cancer imaging. In 2014, he moved to the neighboring University of Texas at Dallas (UTD) as an Assistant Professor in the Department of Physics wherein he leads a research group that applies this hyperpolarization technology for non-invasive diagnostic assessment of cancer. He was promoted to Associate Professor of Physics with tenure at UT Dallas in 2020.

LECTURE: Hyperpolarized Magnetic Resonance: Enhancing NMR and MRI Signals by >10,000-fold for Metabolic Assessment of Cancer

Nuclear magnetic resonance (NMR) spectroscopy and imaging (MRI) of nuclei other than a proton, especially of mass-limited samples, is hampered by the low signal sensitivity due to the tiny differences in spin populations between the nuclear Zeeman energy levels. This intrinsic NMR insensitivity of nuclei such as carbon-13 or nitrogen-15 stems from their relatively low gyromagnetic ratio, leading to lower Boltzmann-dictated thermal nuclear polarization, thus lower NMR or MRI signal. Dynamic nuclear polarization (DNP) or hyperpolarization via the dissolution method, an offshoot of a technology used in particle physics and nuclear scattering experiments, has solved this insensitivity problem by amplifying the magnetic resonance signals of insensitive nuclei such as carbon-13 by >10,000-fold. In this process, a sample with the target nuclei is typically dissolved in a glassing matrix (e.g. glycerol:water solution) and doped with trace amount of stable organic free radicals (e.g. trityl OX063 or TEMPO). The trick is to transfer the high electron thermal polarization to the nuclear spins via microwave irradiation close to the electron spin resonance (ESR) frequency of the free radicals at low temperature (close to 1 K) and high magnetic field (>1 T). To harness these amplified NMR signals at cryogenic temperatures, the frozen polarized samples are rapidly dissolved into hyperpolarized liquids at physiologically tolerable temperatures in a span of 5-10 s. These hyperpolarized liquids are then administered in vitro in NMR tubes with cancer cell suspensions or injected in vivo in living subjects for real-time biochemical monitoring and imaging of cellular metabolism. In this talk, I will delve into the discussion of the physics, instrumentation and engineering aspects, optimization methods, and biomedical applications of the dissolution DNP technology. This cutting-edge physics technology is currently improving cancer diagnostics by providing biochemical and metabolic information at the molecular level with superb sensitivity and high specificity.