IEEE Magnetics Society Lecture

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Porous Media, Magnetic Resonance, and Machine Learning

Abstract: Porous material is ubiquitous in nature and human life. Rocks, soil, concrete, wood, food, and biological tissues are good examples. They are intrinsically multi-phasic, and their microstructure is critical for their functions. In recent years, NMR/MRI has become an important technique for characterization of a variety of porous media for petroleum exploration, material sciences, and medical imaging. This talk will outline a wide range of techniques used for in situ measurement of the material porosity, and their physical mechanisms. Examples of NMR/MRI methods will be discussed including multi-echo techniques, compressed sensing, 2d methods with applications in polymer degradation, molecular composition, porosity in sedimentary rocks, food products and biological tissues.

In particular, we will highlight the practical challenges and novel hardware innovation such as non-resonant MR electronics and miniaturization using ASIC. We will discuss Bayesian approach to understand the measurement uncertainty and machine learning concept for real-time optimization of the data acquisition to achieve fast and robust measurements.

Biography: Dr. Yiqiao Song is currently a Scientific Advisor at Schlumberger-Doll Research. He earned his BS from Peking University and Ph.D. from Northwestern University. He worked in UC Berkeley as a Miller Research Fellow before joining Schlumberger in 1997. His focus has been developing NMR/MRI/NQR methodologies and instrumentation, understanding materials including porous media (e.g. rocks, cements and composites), complex fluids (crude oils, emulsion, mixtures) and biological materials. He is also affiliated part-time at Massachusetts General Hospital to study complex tissue structures and applications to medical imaging. He was elected Fellow of American Physical Society in 2009 and to the Editorial board of Journal of Magnetic Resonance. Dr. Song has published over 140 papers in scientific journals and awarded over 40 patents.