PHYSICS COLLOQUIUM

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Superfluid Helium Cryogenics: From the Macroscopic to the Microscopic

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Liquid helium at temperatures below about 2.2 K becomes a superfluid with associated unique properties: mass flow without friction; anomalous heat transport by thermal counterflow; and second sound (thermal waves in superfluid helium). These properties make superfluid helium useful in large scale applications in superconducting magnets, accelerator technology and space based experiments.

Since its discovery over a 100 years ago, superfluid helium has been extensively investigated using various global measurement techniques such as temperature, pressure probes as well as second sound attenuation. Such measurements provide valuable information about superfluid dynamics; however, they are model dependent and cannot directly measure the flow field or the existence of quantized vortex lines in the turbulent state. For these reasons, researchers have long been interested in developing techniques to visualize the dynamics of superfluid helium.

The talk will begin with an overview of superfluid helium application in magnets, accelerators and space. This introduction will be followed by a summary of the unique properties of superfluid helium that enables these applications. The talk will then describe the microscopic nature of the superfluid state specifically quantized vorticity and consider how to use of modern flow visualization technique to study superfluid dynamics. The unique challenges to performing liquid helium visualization experiments will then be described along with results from several recent experiments at Florida State University.

Dr. Van Sciver *retired from Florida State University in December 2016. Prior to retirement he was a John H. Gorrie Professor of Mechanical Engineering and Distinguished Research Professor at the National High Magnetic Field Laboratory (NHMFL). Dr. Van Sciver joined the FAMU-FSU College of Engineering and the NHMFL in 1991, initiating and teaching a graduate program in magnet and materials engineering and in cryogenic thermal sciences and heat transfer. He also led the NHMFL development efforts of the cryogenic systems for the NHMFL Hybrid and 900 MHz NMR superconducting magnets. Between 1997 and 2003, he served as Director of Magnet Science and Technology at the NHMFL. Dr. Van Sciver is a Fellow of the ASME and the Cryogenic Society of America and former American Editor for the journal Cryogenics. He is the 2010 recipient of the Mendelssohn Award and the 2017 recipient of the Collins Award.*

Prior to joining Florida State University, Dr. Van Sciver was Research Scientist and then Professor of Nuclear Engineering, Engineering Physics and Mechanical Engineering at the University of Wisconsin-Madison from 1976 to 1991. During that time he also served as the Associate Director of the Applied Superconductivity Center. Dr. Van Sciver received his BS in Engineering Physics from Lehigh University in 1970 and his PhD in Low Temperature Physics from the University of Washington-Seattle in 1976.

During his career, Dr. Van Sciver has authored of over 200 publications and patents in low temperature physics, liquid helium technology, cryogenic engineering and magnet technology. He has also supervised the graduate education of 25 PhDs and 15 MSs in the fields of cryogenics and magnet technology. He is also author of the textbook, Helium Cryogenics, originally published by Plenum Press in1986, Helium Cryogenics 2nd ed. was published by Springer in 2012.