Preface

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This special issue of the Journal of Low Temperature Physics celebrates the careers of David M. Lee and John D. Reppy, two senior faculty at Cornell University who, through their seminal accomplishments, have contributed to major progress in low temperature physics. This two-part volume marks their ninetieth birthdays. The collection of articles here includes current research as well as historical context.

Dave and John met and became lifelong friends in 1954 at the University of Connecticut where they were studying for their Master Degrees. Dave left Connecticut and enrolled in the PhD program at Yale in 1955, and John joined Dave 1 year later. Each received their PhD's having performed groundbreaking experimental work with liquid helium. Dave studied liquid ^3He in Henry Fairbank's laboratory at Yale, graduating in 1959, and immediately joined the Cornell faculty. John studied the superfluid properties of ^4He in C.T. Lane's laboratory and was awarded his PhD in 1961. After 1 year as a postdoctoral fellow in Oxford, John was appointed Assistant Professor at Yale. In 1966, he joined Dave as an Associate Professor at Cornell. Very shortly thereafter, Bob Richardson came to Cornell from Duke University, having completed his PhD in 1965 with Horst Meyer on NMR studies of solid ^3He . These three colleagues at Cornell University established one of the most influential schools of low temperature physics for the study of quantum fluids and solids. Most notable among the accomplishments is the discovery and investigation of superfluid ^3He . For that discovery, Dave Lee and Doug Osheroff, his graduate student, and Bob Richardson were recognized with the 1996 Nobel Prize. The ensuing research at Cornell covered a broad range of superfluid properties including nuclear magnetic resonance, acoustics, and superfluid density, the latter investigated by John Reppy's group. Within a year of the announcement of this important observation, there was a

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Dave Lee and John Reppy. International Conference on Quantum Fluids and Solid, Paris, 1997.

global explosion of interest in ^3He , rapidly followed by extensive experimental and theoretical results.

In the late 1960s, Dave Lee became interested in the solid phase of ^3He . The most fascinating aspect of this system is its quantum exchange, literally atomic exchange. Since ^3He is a fermion with a nuclear spin $\frac{1}{2}$, this exchange is equivalent to a Heisenberg-like interaction with entropy at high temperatures, approaching $R\ln 2$. With decreasing temperature, the entropy decreases with a corresponding modification of all of its physical properties which reflect important details of this exchange interaction. To investigate this system, Dave developed ultralow temperature techniques building on the invention of the dilution refrigerator by Henry Hall at Manchester but extending it to much lower temperatures. Dave Lee's inspiration was to use Pomeranchuk refrigeration to provide this capability. The method was proposed by Pomeranchuk and first demonstrated by Anufriev in Moscow and is based on conversion of liquid ^3He to solid with attendant cooling from latent heat. The Cornell group achieved unprecedentedly low temperatures in liquid helium with this method, leading to their discovery of the superfluid phases. Shortly afterward, John Wheatley's group at La Jolla, alerted to the discovery at Cornell, used adiabatic demagnetization of cerium magnesium nitrate to indirectly cool the liquid phase, opening investigation of superfluidity over a broad range of pressure. At Cornell, John Reppy and his student Arne Yanof used this type of refrigeration to determine ^3He superfluid density. For that purpose, they developed a relatively high Q pendulum oscillator and measured the fourth sound in the superfluid.

While John made very important contributions to the study of superfluid ^3He , he is particularly known for his seminal experiments in superfluid ^4He . At Yale, he carried out a series of elegant gyroscopic experiments that clarified the properties of persistent currents. In addition to the physical pendulum technique mentioned above, he conceived and perfected a high-frequency and high mechanical Q Andronikashvili torsional oscillator technique for the study of superfluids. If the torsional oscillator (TO) is carefully constructed and the stiff torsion rod is made from high mechanical Q material, the resonant period can be stabilized and resolved to a fraction of a

nanosecond (ns) out of 1 or 2 milliseconds (ms). For a ^4He film adsorbed on a high surface area substrate, a TO can easily resolve the superfluid decoupling of 1% of a monolayer. This technique was used by David Bishop and John in confirming the Kosterlitz–Thouless vortex–anti-vortex unbinding theory of two-dimensional superfluidity in helium films. It was also used by John and his students for studies of helium films adsorbed in different porous media that clarified the effect of disorder and impurities in systems undergoing continuous phase transitions.

Dave, John, and Bob served as role models for generations of graduate students and post-docs who were trained in the H-corridor of the Clark Hall basement at Cornell. Their enthusiasm and devotion for physics was, and continues to be, contagious. It was a great loss to the low temperature physics community when Bob Richardson died in 2013. Dave and John showed themselves to be marathon scientists. After retiring from Cornell in 2009, Dave moved to Texas A&M University and established a new laboratory there continuing on a subject that he started at Cornell, specifically spin-polarized hydrogen atoms. He is currently running a vibrant group with Vladimir Khmelenko studying spin-polarized hydrogen atoms embedded in various inert cryogenic hosts. John officially retired from Cornell in 2005, but he was immediately ‘called back’ from retirement to join the effort in pursuing the ‘elusive’ supersolid. He and his students published a series of important papers between 2006 and 2016 that helped to sort out the true origin of the observed phenomenon.

We speak for all the contributors of these two volumes by expressing our delight in having this opportunity to honor Dave and John for their inspiring and consequential careers as scientists and mentors.

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