MAR16-2015-000695

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Flow visualization in superfluid helium-4 using He2 molecular tracers[1]

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Flow visualization in superfluid helium is challenging, yet crucial for attaining a detailed understanding of quantum turbulence. Two problems have impeded progress: finding and introducing suitable tracers that are small yet visible; and unambiguous interpretation of the tracer motion. We show that metastable He_2 triplet molecules are outstanding tracers compared with other particles used in helium. These molecular tracers have small size and relatively simple behavior in superfluid helium: they follow the normal fluid motion at above 1 K and will bind to quantized vortex lines below about 0.6 K. A laser-induced fluorescence technique has been developed for imaging the He_2 tracers. We will present our recent experimental work on studying the normal-fluid motion by tracking thin lines of He_2 tracers created via femtosecond laser-field ionization in helium. We will also discuss a newly launched experiment on visualizing vortex lines in a magnetically levitated superfluid helium drop by imaging the He_2 tracers trapped on the vortex cores. This experiment will enable unprecedented insight into the behavior of a rotating superfluid drop and will untangle several key issues in quantum turbulence research.

[1]We acknowledge the support from the National Science Foundation under Grant No. DMR-1507386 and the US Department of Energy under Grant No. DE-FG02 96ER40952.