Study on the Turbulent Flow of Superfluid ^{4}He generated by a Vibrating Wire

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We have studied the turbulent flow of superfluid ^{4}He generated by an oscillating object. We prepared a very thin wire with a 2.5 μm diameter made of NbTi and formed a vibrating wire from it as the oscillator. As increasing drive, the oscillation of the wire grows up in superfluid ^{4}He, but its velocity suddenly drops and gradually increases at higher drives. It is easily understood that the high speed oscillation of the wire creates vortices and the stream around it develops into turbulence. The superfluid flow generates the unstable expansion of the vortex strings attached to the wire because of the Glaberson-Donnelly instability after its velocity becomes higher than a certain velocity. The turbulence disappears in a decreasing drive process at a non-zero velocity, which derives a finite size of the vortices even in the turbulence. We also measured the resonance frequency of the wire, estimated an extra thickness as the extra moment of the vibrating wire, and found that the extra thickness increases gradually with velocity but decreases steeply after the stream changes into the turbulence. The creation of vortices might cause the energy loss and increase the moment of the wire. The decrease of the moment in the turbulence implies that the size of the attached vortices should reduce more effectively than the moment increases. Vortices might expand, tangle, and reconnect themselves in the turbulence. The tangle and reconnection process may reduce the size of the attached vortices.

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