Two Types of Quantum Turbulence: Mechanically versus Thermally Driven ^{4}He Superflow in a Channel

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We report an experimental study of ^{4}He quantum turbulence for 1.3 K $< T <$ 2.0 K. A flow was generated by a stainless steel compressible bellows pushing liquid helium through a channel 7×7 mm^2 in cross-section with ends blocked by silver sinter superleaks, thereby obtaining a net flow of the superfluid component only. We have deduced the density of quantized vortex lines in the middle of the channel length from the extra attenuation of second sound propagating perpendicular to the flow. We have identified the onset, and studied the steady state and the temporal decay of turbulence as a function of superflow velocity and temperature. The nature of quantum turbulence emerged is significantly different from that of a previous study [PRL **100**, 315302 (2008); JLTP **153**, 162 (2008)], where the very same flow channel and detection technique were used, but the flow was driven thermally by a helium fountain pump. In the present study turbulence onsets at ten times lower velocity and in the steady state the observed vortex line density is about an order of magnitude higher, proportional to the square of the flow velocity, with no indication of a transition to a linear behavior at high velocity as seen before. This difference suggests strongly that the manner in which quantum turbulence is generated in our channel critically determines its nature.