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Optical Pulse-Driven Integrated Quantum Voltage Noise Source for Johnson Noise Thermometer

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We have developed an integrated quantum voltage noise source (IQVNS) as a reference signal source for the Johnson noise thermometer. The Josephson effect ensures that the power spectral density of the output signal of IQVNS is described by a combination of Planck's constant h , elementary electric charge e , clock frequency of IQVNS f_c , and numerical coefficient. One of the features of IQVNS is that it has a random number generator on the superconducting device. Therefore, it is not necessary for IQVNS to use a pulse pattern generator that can be an unwanted electrical noise source for the Johnson noise thermometer. However, IQVNS is coupled with a microwave oscillator for supplying a clock signal using a metallic coaxial cable, and there is still a possibility of picking up unwanted noise signals.

In this study, we tried to eliminate the metallic wiring to IQVNS completely by using optical pulse as clock signal to IQVNS. The light pulse transmitted through the optical fiber is converted into a current pulse by a photodiode mounted on the IQVNS probe head. Using this optical pulse driven IQVNS, the thermal noise of the resistor placed at the triple point of water was measured, and the temperature of the triple point of water was derived.

Keywords: Johnson noise thermometry, quantum voltage noise source, rapid single flux quantum circuit, Optical pulse