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Development of Superconducting Tunnel Junction Detectors as a far-infrared single photon detector for neutrino decay search

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We present the development of Superconducting Tunnel Junction (STJ) detectors as far-infrared single photon detector motivated by application to a search for radiative decay of cosmic background neutrino. The photon energy spectrum from the neutrino radiative decays is expected to have a sharp edge at high energy end in a far-infrared region ranging from 14meV to 25meV (from 50um to 90um in wavelength). We explore the the cosmic infrared background photon energy spectrum in this region for feeble contribution from neutrino decays. Thus, the detector is required to measure photon-by-photon energies with high resolution enough to identify the edge structure, and designed for a rocket or satellite experiment.

One of our choices for the detector is STJ using hafnium (Hf-STJ) which is expected to have 2% energy resolution for single photon of 25meV due to very small gap energy of hafnium. Another choice for the detector is a combination of the diffraction grating and array of niobium-aluminum STJ (Nb/Al-STJ) pixels, where each Nb/Al-STJ pixel is capable of single photon detection for a far-infrared photon delivered to each pixel according to its wavelength by the grating. For the Hf-STJ development, we have successfully produced a superconducting-insulator-superconducting structure using hafnium, that is confirmed by Josephson current, and observed a response to visible light illumination, although much higher leak current than its requirement is a major issue to be resolved. For the Nb/Al-STJ, it is also challenging that an amplifier at extremely low noise level of 10 electron-equivalent-noise is required.

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