Photon noise limited performance over an octave of bandwidth of Kinetic Inductance Detectors for sub-millimeter astronomy

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We present the development of background limited kinetic inductance detectors (KIDs) for sub-millimeter (sub-mm) astronomy applications to be used in space based observatories. The sub-mm radiation is coupled to the KID via a leaky wave antenna covering the frequency range from 1.4 to 2.8THz. We have developed a hybrid niobium titanium nitride/aluminium (NbTiN/Al) KID, fabricated on a silicon (Si) substrate, in which the leaky wave antenna and absorbing section of the KID are fabricated on a suspended silicon nitride (SiN) membrane. The radiation is coupled to the leaky wave antenna with a Si lens placed on top of it at a distance of 3mm. We observe photon noise limited performance both in the phase and amplitude readout simultaneously, with a good optical efficiency at a frequency of 1.55THz. The Fourier Transform Spectroscopy (FTS) measurements show the broadband radiation coupling for an octave of bandwidth, and the beam pattern measurements at 1.55THz are in agreement with the simulated patterns. In summary, we have developed a new fabrication route that assures photon noise limited performance, and a scalable assembly method that provides the 3mm gap space between the antenna and the lens. These developments assure background limited performance with a broad frequency coupling over an octave of bandwidth for sub-mm radiation. Given these results, hybrid NbTiN/Al leaky wave antenna coupled KIDs will enable astronomically usable kilopixel arrays for sub-mm imaging for future space missions.