Development of high-Q superconducting resonators for use as Kinetic Inductance detectors

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One of the largest challenges in the development of future radiation detectors for space applications is the fabrication of large detector arrays. This because future missions require camera's with many pixels, in combination with background limited sensitivity. Within this context we have started the development of Microwave Kinetic Inductance Detectors (MKID's). The MKID is a relatively new detector concept pioneered by J. Zmuidzinas and P. Day et al. (1), which belongs to the class of pair breaking detectors, where radiation is absorbed in a superconducting film by breaking Cooper pairs into quasiparticles. The operating temperature of the device is 1/10 of the transition temperature of the superconducting film, Hence an Aluminum KID should be operated at 100 mK. The MKID measures the change in quasiparticle (and Cooper pair) density by probing the complex surface impedance of the superconductor. This is done by making use of an extremely high Q superconducting quarter wavelength microwave thin film resonator. Every resonator, each with slightly different resonance frequency, can be observed simultaneously. With only one wideband cryogenic amplifier, 2 coaxial cables from room temperature to the cold stage and commercially available readout electronics a camera with in excess of 100.000 pixels could become a reality. KIDs can address the spectrum from far infrared to X-ray, depending on the antenna or absorber coupled to the microwave resonator.

[1] P.K. Day, H.G.LeDuc, B.A. Mazin, A. Vayonakis and J. Zmuidzinas, Nature 425, p.817-821 (2003).