Submillimeter wave detection using Josephson fluxonic diode

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We present simulation results on 0.5-0.8 THz detection properties of Josephson Fluxonic Diode (JFD) in its avalanche multiplication mode. JFD is a long Josephson junction to which a spatially reversing magnetic field is applied. Vortices fill half of the junction and antivortices fill the other half. JFD has a forward and a reverse bias mode of operation depending on the direction of bias current. Forward bias corresponds to a voltage state and reverse bias corresponds to a short circuit. When reverse biased, if the magnitude of magnetic field is larger than a threshold value and bias current is large enough, vortex and antivortex pairs are generated at the center and a voltage state is created. This phenomenon is similar to avalanche breakdown in semiconductor pn junctions. And similar to avalanche photodiodes it can be used to detect electromagnetic radiation. The interesting property of JFD is that the frequency and strength of the radiation necessary for pair-generation depends on the magnetic field and bias current.

Any radiation which affects Cooper pair density, the strength of magnetic field, or can modulate the bias current can cause pair generation. By biasing the junction at a certain current a predetermined frequency can be detected. Changing the bias current then changes the detected frequency. There are several advantages associated with JFD compared to regular quasi-particle SIS junctions. Such advantages include: a relatively large size comparable to radiation wavelength causing a better match to radiation, much larger voltage and currents at the operating point, and the ability to detect a very wide range of frequencies up to infrared and X-rays.