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Status of the SIMP project: Towards the Single Microwave Photon Detection

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The low-mass frontier of Dark Matter, the measurement of the neutrino mass, the search for new light bosons in laboratory experiments, all require detectors sensitive to excitations of meV or smaller. Faint and rare signals, such as those produced by vacuum photoemission or by an Axion in a magnetic field, could be efficiently detected only by a new class of sensors.
The Italian Institute of Nuclear Physics (INFN) has financed the three-year SIMP project (2019-2021) in order to strengthen its skills and technologies in this field with the ultimate aim of developing a single microwave photon detector.
This goal will be pursued by improving the sensitivity and the dark count rate of two types of photodetectors: current biased Josephson Junction (JJ) for the frequency range 10-50 GHz and Transition Edge Sensor (TES) for the frequency range 30-100 GHz.
Superconducting circuits based on JJ have been used in the last decades for the realization of artificial atoms with level spacing of few to several GHz sensitive to single microwave photons. In particular, in current biased JJ, the absorption of a photon induces a resonant transition from the superconducting to the resistive state, producing a measurable voltage signal.
The TES calorimeter sensitivity is limited by the magnitude of the thermal energy fluctuations, due to the energy exchange between the sensor and the phonon bath. To obtain an energy resolution lower than 0.1 meV the proximity effect between a superconducting material (Ti or Al) and a normal metal (Au or Cu) will be exploited in order to fabricate a device with a volume of ~10^6 nm^3 and a transition temperature of 40 mK or lower. Preliminary results on materials and devices characterization will be presented.

Less than 5 years of experience since completion of Ph.D

N

Student (Ph.D., M.Sc. or B.Sc.)

N

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