Contribution ID: **76** Type: **Invited Presentation**

Intrinsic dark counts in superconducting nanostrip single-photon detectors: the role of multiple fluctuation events in NbN and NbTiN

Tuesday, July 23, 2019 9:00 AM (15 minutes)

Superconducting Nanostrip Single-Photon Detectors (SNSPDs) are promising devices in many fields ranging from single-photon source characterization to optical communication and quantum cryptography. An important feature of SNSPDs is their low dark count rate (DCR), that increases close to the critical current where the detection efficiency is higher. In such a region DCR is dominated by a spontaneous resistive-state formation. The investigation of the origin of DCR toward optimization of SNSPD performances is crucial. Phase slip switching events have been considered recently as possible sources of dark counts in SNSPDs: a phase slip event is any process leading to a quantized phase change of the order parameter by 2p able to produce a finite voltage across the strip. Phase slip events include single vortices crossing an edge barrier and vortex-antivortex pairs splitting under the action of the Lorentz force driven by the bias current. In this work, we investigate phase slip events in 2D-NbN and NbTiN nanostripes, e,g, 5 nm thick and 80 nm wide. These materials are of great interest and widely used in SNSPD applications where very low dark count rates are requested. We measure the switching current distributions in a wide interval of temperatures from 6 K down to 0.3 K. The standard deviations of the switching distributions show an extended region at high temperatures where Multiple Phase Slip (MPS) switching events occur. This is probably related to a decreasing of the switching current and an increasing of the electron and phonon capacities: both phenomena cause a lower dissipation during the phase slip event. In this temperature region the width of the switching distribution, and therefore the DCR, is considerably reduced down to values below those observed at the lowest temperature. Finally, we also quantify the energy scale of the fluctuation phenomena. The proposed experimental approach may result in a powerful tool for the diagnostic of SNSPD operation mode.

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

N

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

N

Primary author: Dr PARLATO, Loredana (Dip. di Fisica, Università degli Studi di Napoli 'Federico II', Napoli, Italy and CNR –Institute of Superconductors, Innovative Materials and Devices, Napoli, Italy)

Co-authors: Dr EJRNAES, Mikkel (CNR –Institute of Superconductors, Innovative Materials and Devices, Pozzuoli, Italy); Dr SALVONI, Daniela (Dip. di Fisica, Università degli Studi di Napoli 'Federico II', Napoli, Italy); Dr MASSAROTTI, Davide (Dip. di Fisica Universita' di Napoli "Federico II", Napoli, Italy); Dr CARUSO, Roberta (Dip. di Fisica, Università degli Studi di Napoli "Federico II", Napoli, Italy and SeeQC-eu, Roma, Italy); Prof. TAFURI, Francesco (Dip. di Fisica, Università degli Studi di Napoli 'Federico II', Napoli, Italy and CNR –Institute of

Superconductors, Innovative Materials and Devices, Napoli, Italy); Prof. YANG, Xiaoyan (State Key Lab of Functional Materials for Informatics, Shanghai Institute of Microsystem and Information Technology (SIMIT), Chinese Academy of Sciences (CAS), Shanghai, P. R. China); Prof. YOU, Lixing (State Key Lab of Functional Materials for Informatics, Shanghai Institute of Microsystem and Information Technology (SIMIT), Chinese Academy of Sciences (CAS) and CAS Center for Excellence in Superconducting Electronics (CENSE), Shangai P.R. China); Prof. WANG, Zhen (State Key Lab of Functional Materials for Informatics, Shanghai Institute of Microsystem and Information Technology (SIMIT), Chinese Academy of Sciences (CAS), and Center for Excellence in Superconducting Electronics (CENSE), Shanghai,, P. R. China.); Prof. PEPE, Giovanni Piero (Dipartimento di Fisica, Università degli Studi di Napoli 'Federico II', Napoli, Italy and CNR –Institute of Superconductors, Innovative Materials and Devices, Napoli, Italy); Dr CRISTIANO, Roberto (CNR –Institute of Superconductors, Innovative Materials and Devices, Pozzuoli, Italy)

Presenter: Dr PARLATO, Loredana (Dip. di Fisica, Università degli Studi di Napoli 'Federico II', Napoli, Italy and CNR –Institute of Superconductors, Innovative Materials and Devices, Napoli, Italy)

Session Classification: Orals LM 001

Track Classification: Low Temperature Detector Development and Physics