Superconductivity for Wave-like Dark Matter Searches

D. Maiello[1,2], R. Di Vora[3], D. Ahn[2], G. Carugno[2], A. Ortolan[3], G. Ruoso[3], G. Sardo Infirri[1,2], C. Braggio[1,2]

[1] *Dipartimento di Fisia e Astronomia, 35131 Padova, Italy*
[2] *INFN, Sezione di Padova, 35131 Padova, Italy*
[3] *INFN, Laboratori Nazionali di Legnaro, 35020 Legnaro, Padova, Italy*

Dark matter (DM) may consist of extremely light particles exhibiting wave-like behavior, such as axions or dark photons. These candidates can convert into photons, generating a small but potentially measurable oscillating electromagnetic field.

In this contribution, I will present recent activities at the QUAX laboratory at LNL–INFN. Detecting such elusive particles requires simultaneously boosting the signal and minimizing microwave receiver noise, two demanding tasks that can be addressed using state-of-the-art superconducting technologies.

To enhance the signal, we exploit of the high quality factors of superconducting resonators, including cavities coated with NbTi and Nb_3Sn, as well as devices based on REBCO tapes. These type-II superconductors are particularly suitable because they can operate in the multi-tesla magnetic fields required for axion searches.

To reduce receiver noise, we employ cryogenic sensors based on superconducting circuits capable of operating at the Standard Quantum Limit (SQL), such as travelling-wave parametric amplifiers (TWPAs). To overcome the SQL, we use a sensor based on a transmon qubit that enables single microwave photon detection. This approach significantly increases the rate at which the dark-matter parameter space can be explored.