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Superconducting Quantum Interference Devices and Applications

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Superconducting Quantum Interference Device (SQUID) is the most sensitive detector of the magnetic flux ranging from dc to MHz frequency and has widely been used in applications. One of the most intersesting applications of SQUID is in biomagnetism.. From the physiological or the medical point of view, the goal of the SQUID technology is to obtain the information of different organs of the human body. Considering for instance the human brain, the SQUID technique for biomagnetic imaging helps the neurophysiologist to better understand how the brain works or helps the medical doctor in his diagnosis of the neurological disorder. Looking from the physics side, the final goal is to find the sources, i.e., the current density flowing in the biological issue. We note this technology is non-invasive and therefore it will be safely used in investigating the functionality of different organs. By measuring the magnetic field as a function of time, we will be able to determine how the activation evolves with time in the organs investigated. In this talk we report the development of step-edge substrates for SQUIDs, fabrication and characterization of high-T_c SQUIDs, noise characterization and biomagnetic applications. The SQUIDs are in serial arrangement and with different junction widths. In biomagnetism, the 1^{st}-order electronic gradiometer system is set up to measure the magnetocardiograms (MCG) of animals in moderate magnetically shielded environment with active compensation. The active compensation reduces the noise level and improves the performance of the MCG system. In experiments, the X-Y translation stage is used to move the objects to be tested. The noise measured by the 1^{st} order gradiometer MCG system in this moderate magnetically shielded room was about 1 $pT/Hz^{1/2}$ above 1 Hz. Therefore, MCG measurements of animals can be performed in the moderate shielded environment and a two-dimensional MCG mapping was obtained. The current density mapping due to the dipole sources were derived and the results are discussed. Research on the low field nuclear magnetic resonance based on high-T_c SQUID using polarized noble gas is briefly reported.

keywords : SQUID, electronic gradiometer, noise