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SQUID-Detected Relaxation Phenomena in the Ensembles of Superparamagnetic Nanoparticles

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The HTS SQUID microscopy is applied for measuring the magnetization relaxation of the ensembles of non-interacting Fe_3O_4 nanoparticles dispersed in the rigid polymer matrix preventing nanoparticles from the agglomeration. The Transmission Electron Microscopy (TEM) is used to determine the size distribution of magnetic nanoparticles and to control the homogeneity of their spatial distribution in the matrix.

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A SQUID System for Geomagnetic Archaeometry

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With magnetic mapping of the Earth's magnetic field a view into the shallow subsoil is possible. High resolution measurement of magnetic field variances in dependence on the position on the ground can give information about buried ancient structures. For that purpose, a low-T_c SQUID gradiometer system was set up, which offers extremely high sensitivity, at the same time suppresses disturbances to a high degree, and allocates the magnetic field gradient data exactly to the position on the ground. The complete system for geomagnetic archaeometry comprises a non-metallic cart with separately suspended wheels for gentle movement with the SQUID system and a GPS antenna for position determination. Additionally, a radio frequency antenna receives the data from a reference GPS station, thus enabling differential GPS with a position resolution in the centimeter range. Furthermore, an inertial system is integrated which allows the calculation of the real SQUID position from the measured GPS antenna position. The results of several field trials with this SQUID system at archaeologically interesting places are shown.

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Biomagnetic Measurement System for Magnetoencephalogram on Mice

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We have been developing a biomagnetic measurement system for the magnetoencephalogram (MEG) on genetically modified or drug-induced "disease-model" mice. MEG is a contact-free and non-invasive technique of functional brain imaging that has been widely used in neurophysiological screening on human. The use of MEG in experimental animals is also expected to connect the results of the non-invasive screenings on human and the pathology on disease-model animals. We are going to establish a MEG system on mice, since mice are the most popular experimental animals and a large variety of disease-model mice have been already generated. Our initial model of biomagnetic measurement system using a LT_c-SQUID magnetometer has the field sensitivity of 1.3 $pT/\sqrt{Hz}$ in the white-noise region (10 Hz-10 kHz). And we succeeded to obtain functional magnetocardiogram maps on the mice thorax using the system. However in its application to MEG measurement, more than 5000 times of averaging, corresponding to more than two hours measurement, might be required to obtain clear MEG waveform. Therefore we improved the system noise for applicable MEG measurement. The material of window cap, which holds sapphire glass window on the dewar tail, has been changed from aluminum into ceramic. The magnetic field sensitivity of the new system is estimated to decrease to less than half in the white noise region. For an initial MEG measurement on mice, we also developed the non-magnetic whisker stimulator using a piezoelectric sensor to evoke somatosensory responses (somatosensory evoked field; SEF) in barrel cortex. The presented paper will describe the improved system and the stimulation system in detail. The preliminary result on SEF on mice measured using the improved system will be presented.