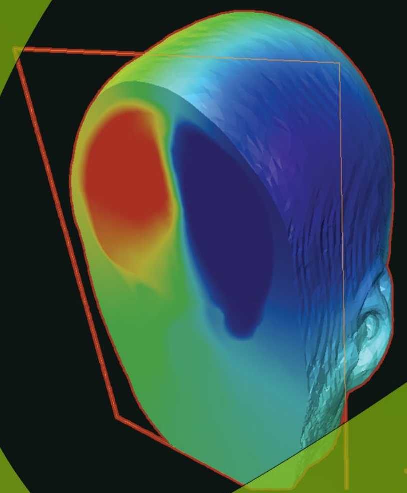

The SQUID as Diagnostic Tool in Medicine and its use with other Experimental Stimulation and Theoretical Methods for Evaluation and Treatment of Various Diseases

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ISBN: 978-960-474-289-9

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Published by WSEAS Press
www.wseas.org

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All papers of the present volume were peer reviewed by two independent reviewers. Acceptance was granted when both reviewers' recommendations were positive.
See also: http://www.worldses.org/review/index.html

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World Scientific and Engineering Academy and Society

Preface

In this book we are going to deal with an important subject namely, the magnetic fields emitted from human subjects for the purpose to understand and evaluate normal and abnormal functions and furthermore for the treatment of CNS disorders. The ionic currents which are originated from biochemical sources at the cellular level in the central nervous system (CNS) produce not only electric fields, but also magnetic fields.
These fields can be measured in the brain and surrounding tissues by very sensitive and sophisticated magnetic field detectors which are called SQUID's. The behavior of these fields can be predicted because they obey physical laws. The generation of the electroencephalogram (EEG) signals in the brain, in biophysical terms, is the exact way to determine the potential distribution at the scalp given a set of intracerebral current sources. In general terms, the field potential of a population of neurons equals the sum of the field potentials of the individual neurons. In order to understand the EEG phenomena, the activity of a population of neurons must always be considered. EEG phenomena can only be measured at a considerable distance from the source if the responsible neurons are regularly arranged and activated in a more or less synchronous way. Thus, while with the EEG it is very difficult to localize where a particular signal originates in the brain, in the case of the magnetic field and with the use of the (magnetoencephalogram) MEG it is easier to localize where the signals originate from the brain. The MEG is presently regarded as the most efficient method for recording the brain activity in real time for many reasons. Compared with the EEG, the MEG has unique sensitivity to the CNS disorders and normal functions of the brain. In addition, the MEG offers functional mapping information and measurement of brain activity in real time, unlike CT, MRI and fMRI which only provide structural, anatomical and metabolic information. With the MEG the brain is seen in 'action' rather than viewed as a still image. Another most important point is that the MEG has far more superior ability to resolve millisecond temporal activity associated with the processing of information which is the main task of our brain. Furthermore, another characteristic point is that the disturbing fields, namely the earth magnetic field and the urban magnetic noise (10^{-4} to 10^{-3} G) are almost constant over large distances, whereas the MEG falls off rapidly with distance. Other properties of the MEG that should be mentioned are the following. Neither electrodes nor a reference point are necessary for recording the MEG compared to the EEG; the transducers for the MEG need not touch the scalp, because the magnetic field does not disappear where conductivity is zero(free space).
The recordings of the MEG are the measurements of the magnetic fields perpendicular to the skull, which are caused by tangential current sources. By contrast, the EEG is a measure of both components. This means that the MEG measures the cortical activity lying in the sulci and not in the convexity of the gyri.
Thus, taking into account all of the above characteristic information, the magnetoencephalography is an important research field which is evolving quickly and a number of interesting findings in the following chapters we are going to be reported with respect to normal and abnormal functions of the human subjects.

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Summary

Since a flow of electrical charges produces a magnetic field, the current in the heart during depolarization and repolarization also produces a magnetic field which is about $5X10^{-11}$T (tesla). To detect and measure such very weak magnetic fields it is necessary to use magnetically shielded room and very sensitive and sophisticated magnetic field detectors. Such sophisticated devices are the ones which are based on the Josephson effect of superconductivity (Ref) and are called SQUID's from the initials of the four words (Superconductive Quantum Interference Device). Such detectors operate at liquid helium temperature which is about 4K (-269^0C) and have the ability to detect magnetic fields of the order 10^{-15} T, whereas the magnetic field of the earth is $3X10^{-5}$T.

The recording of the heart's magnetic field is called magnetocardiogram (MCG), whereas the recording of the magnetic field produced by the flowing of ions in the brain is called magnetoencephalogram (MEG). The information provided by the MEG is entirely different from other imaging techniques and therefore shows considerable promise for brain studies as diagnostic tool and as such it is worth of discussing it in more detail.

Thus, while with the electroencephalogram (EEG) it is very difficult to localize where a particular signal originates in the brain, with the MEG and using different stimulation methods of external weak magnetic fields it is easier the location in the brain where the MEG signals originate from. Furthermore, using the above mentioned external weak magnetic stimulation and comparing the MEG records before and after the application of external magnetic stimulation (EMS) is shown a rapid attenuation of the high abnormal activity, characterized CNS disorders, followed by an increase of the low frequency components toward the patient's α-rhythm. Such an example we are given in a few sample chapters for the proposed book.

Table of Contents

SUBJECT INDEX

Prof. P. Anninos received his B.Sc. in Physics from Physics Department University of Athens, Greece, his M.Sc. from Physics Department Syracuse University, N.Y, 1966 and his Ph.D. of Medical Physics from Physics Department, Syracuse University, N.Y, 1969.
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978-960-474-289-9

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