THE CHANGING PHYSICS OF THE MEG: FROM 1968 TO 2006

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Before dealing with the changing physics, we first outline the MEG generally: how the neural sources in the brain produce an external magnetic field around the head, and how the MEG measures this field. We also outline how the MEG measurements are used, via these steps: the MEG initially produces a sequence of instantaneous magnetic maps over the head, then an inverse solution is performed on the maps to learn about the neural sources which produced the field. But, as we know, physics does not allow a unique solution to this inverse problem, so we guess at the best solution. We will pause here and dwell on the reasons for this non-uniqueness, and also dwell on the simplest "best guess", which is the dipole source in a spherical model of the head; this combination dominated our physics thinking for some years. Finally, because the same sources which produce the MEG also produce the EEG, we outline the important MEG-EEG comparison.

Now, in dealing with the changing physics, we will first follow one particular line. This traces the methods used in measuring the MEG over the head, beginning with the first crude physics measurements in 1968, through the first use of the SQUID (about 1970), through the first SQUID-measured MEG (1971), through increasing multi-channel SQUIDs, culminating in the full-head helmet systems of today. Next, to see the changing physics in the use of these measurements, we will study two published MEG investigations. The first was done about 25 years ago, and the second was done recently; these will demonstrate the huge growth in the thinking and physics of the inverse solution. Then we will move to some recent MEG-EEG comparisons, with some surprising physics results. We will also look at several new experimental developments involving the MEG, and some interesting physics spinoffs. Finally, we will make some comments on what the future might hold for the physics of the MEG.