

A Feasibility Study for Passive Detection of Breast Tumors using Naturally Generated Magnetic Fields

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In the preliminary study carried out by P. Anastasiadis, Ph. Anninos and E. Sivridis, *The Breast*, 3, 177-180, 1994, the biomagnetic field generated by unidentifiable breast lesions was used to characterize the tumors as malignant or benign. Due to the weak magnitude of the generated fields, a highly sensitive magnetometer called Superconducting Quantum Interference Devices (SQUIDS) was employed as the mean of detection. Yet the study did not provide explanation for the mechanism by which this biomagnetic field is generated.

The current paper aims to investigate in depth the mechanism by which growing breast tumors generate biomagnetic fields which is the main motivation behind this work. An estimate to the order of magnitude of the generated fields will determine the feasibility of the detection and the characterization of breast tumors.

In this work two tumor features are considered as the possible origin of biomagnetic field generation. The first is that tumors exhibit uncontrollable cell division and growth which increases their demand for nutrients in order to sustain this rapid growing pattern. These needed nutrients are absorbed from near by blood vessels and healthy cells. Among these nutrients are charged ions such as calcium and iron which are needed for survival and growth of all body cells. The elevated flow of these ions towards the tumor forms electric currents which can generate a biomagnetic field. In order to model this current, a biologically tumor growth model which exhibits the interaction between the growing tumor and the nutrients is developed. From this interaction, the spatial distribution of the nutrients and its variation with respect to the time is calculated. Hence, the electric currents generated by the tumor are calculated. From this current the biomagnetic field will be numerically calculated.

In addition, malignant tumors synthesize a blood network which perforates the tumor in a process termed angiogenesis. This occurs to provide the sufficient nutrients for the even higher growth rates exhibited at this stage. The flow of nutritious ions through these vessels can also be represented as electric currents which contribute to the detected biomagnetic field. Angiogenesis models will be investigated such that the flow of nutrients through the blood vessels can be calculated. Finally, a contrast between the biomagnetic field generated by angiogenesis and that generated by the absorption of nutrients from near by blood vessels and healthy cells will be investigated. Numerical results of the biomagnetic fields generated by the above mechanisms will be presented in the conference.