COHERENT OSCILLATIONS IN BIOLOGICAL SYSTEMS: MODELS FOR AN INTERACTION WITH EXTERNAL STIMULATIONS

[redacted]

Fröhlich has promoted the ideas that electric vibrations with frequencies of the order of 10^{10}-10^{12} Hz should be coherently excited in active biological materials. These coherent oscillations should play an important role in the order and function of biological systems. Therefore one may expect that excitations of the proposed type could possibly lead to changes in the behaviour and function of biosystems.

Based on this concept of coherent oscillations some physical and mathematical models have been developed. In the "Brain Wave Model" long range collective interactions within the Greater Membrane of the brain can establish slow chemical oscillations which are connected to low frequency electric oscillations by means of the large dipole moment of activated enzymes. ELF fields can interact with the internal limitcycle (coherent oscillation); its frequency and field dependent collapse is discussed. Thus an explanation of the extreme high sensitivity of certain biological systems to very weak electromagnetic signals is given: the external stimulus may only serve as a trigger to start an internal response signal. Different types of propagating pulses are presented.

The mathematical modelling of coherent oscillations by limit cycles (self-sustained oscillations) has been developed further. Besides hysteresis behaviour, i.e. bistability, this type of dissipative structures in systems far from thermodynamic equilibrium seems to play a dominant role in chemical, biochemical and biological systems. An extension of a simple limit cycle system which has to include at least two stable limit cycles is presented. This model, which, in addition, can describe threshold and excitability behaviour, may serve as a very first starting point to explain the behaviour (i.e. intensity and frequency windows), which has been found by Adey and his group when the Ca^{2+}-efflux from the brain under stimulation with very weak electromagnetic fields has been measured. A physical basis and interpretation of this purely mathematical model is still under investigation.

In addition some model calculations on a microphysical basis are given which can support Fröhlich's concept of coherent oscillations, metastable highly polarized states and frequency selective interactions in biological systems.