

## WATER ELECTROMAGNETIC IMAGING AND THE POLYMERASE CHAIN REACTION

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We describe [1-3] the dynamic origin of the high efficiency and precise targeting of Taq activity in PCR. The interaction couplings, frequencies, amplitudes, and phase modulations comprise a pattern of fields which constitutes the electromagnetic (em) image of DNA in the surrounding water, which is what the polymerase enzyme actually recognizes in the DNA water environment.

In our modeling we adopt the quantum field theory (QFT) gauge paradigm, describing the interaction between two systems by the mutual exchange of a mediating wave field or quantum, in analogy with the photon exchanged by two electric charges in quantum electrodynamics. DNA, enzyme, and water molecules, whose number under standard biological conditions constitutes the great majority of the system molecules, are characterized by their configurations of electric dipoles. We thus focus our study on the radiative dipole interaction among DNA, enzyme, and water molecules. The wave field mediating DNA-enzyme interactions, of which Taq amplifying DNA sequence in PCR represents one specific case, are thus governed by the dipole wave field propagating through the water matrix in which DNA and enzymes are embedded. London dispersion forces between DNA base pairs and the dynamics of delocalized electrons are shown to be responsible for the formation of the molecular dipole structure. Long-range correlations in the chemistry of DNA-enzyme interactions appear to play a key role in understanding how to reconcile the high efficiency and precise targeting of enzymatic activity with the stochastic kinematics of a large number of molecular components. The highly ordered pattern in the spatial molecular arrangements and the time ordered sequence of steps characterizing the catalytic activity indicate that biochemical methods and the traditional study of the dipole and multipole dynamic structure of the electronic quantum conformations need to be supplemented by results in QFT. These indeed account for the collective molecular long-range correlations, responsible for the highly synchronized, fine-tuned DNA-enzyme interaction. The mathematical formalism and the results of our analysis, provide thus an understanding based on dynamical field-theoretic grounds, supplementing more standard studies of PCR based on kinetic and stoichiometric methods. We find that in PCR amplification processes, and more generally in DNA-enzyme interactions, a pattern of em dipole fields constitutes the em image of the DNA and of the enzyme, in such a way that what the enzyme (the DNA) “sees”, at the level of molecular biology, is such an em image of DNA (of the enzyme) in the surrounding water. The DNA and the enzyme thus “see” each other’s em images by exchanging quanta of the radiative dipole waves induced by their presence in the water molecular matrix.

[1] L. Montagnier, J. Aïssa, A. Capolupo, T. J. A. Craddock, P. Kurian, C. Lavallee, A. Polcari, P. Romano, A. Tedeschi and G. Vitiello, Water Bridging Dynamics of Polymerase Chain Reaction in the Gauge Theory Paradigm of Quantum Fields, *Water* 2017, 9, 339 (2017);

[2] L. Montagnier, J. Aïssa, A. Capolupo, T. J. A. Craddock, P. Kurian, C. Lavallee, A. Polcari, P. Romano, A. Tedeschi and G. Vitiello, Addendum to: L. Montagnier, J. Aïssa, A. Capolupo, T. J. A. Craddock, P. Kurian, C. Lavallee, A. Polcari, P. Romano, A. Tedeschi and G. Vitiello, Water Bridging Dynamics of Polymerase Chain Reaction in the Gauge Theory Paradigm of Quantum Fields, *Water* 2017, 9, 436 (2017).

[3] P. Kurian, A. Capolupo, T. J. A. Craddock, G. Vitiello, Water-mediated correlations in DNA-enzyme interactions, *Phys. Lett. A* 382, 33 (2018).