The DNA-wave Biocomputer

Peter P. Gariaev*, Boris I. Birshtein*, Alexander M. Iarochenko*, Peter J. Marcer**,
George G. Tertishny*, Katherine A. Leonova*, Uwe Kaempf ***.

* Institute Control of Sciences Russian Academy of Sciences,
Moscow, Russia gariaev@aha.ru, http://www.aha.ru/~gariaev, and
Wave Genetics Inc. 87 Scollard Street, Toronto, Ontario, Canada, M5R 1G4,
gariaev@wavegenetics.com,
**53 Old Vicarage Green, Keynsham, Bristol, BS31 2DH, UK,
petermarcer@aikido.freeserve.co.uk, http://www.bcs.org.uk/cybergroup.htm. .
*** Institut f. Klinische, Diagnostische und Differentielle Psychologie- Am
Falkenbrunnen - D-01062 Dresden TU, Dresden, Germany,
uwe@psy1.psych.tu-dresden.de

Abstract
This paper reports experimental work carried out in Moscow at the Institute of Control Sciences, Wave Genetics Inc. and theoretical work from several sources. This work changes the notion about the genetic code essentially. It asserts: -
1) That the evolution of biosystems has created genetic "texts", similar to natural context dependent texts in human languages, shaping the text of these speech-like patterns.
2) That the chromosome apparatus acts simultaneously both as a source and receiver of these genetic texts, respectively decoding and encoding them, and
3) That the chromosome continuum of multicellular organisms is analogous to a static-dynamical multiplex time-space holographic grating, which comprises the space-time of an organism in a convoluted form.
That is to say, the DNA action, theory predicts and which experiment confirms,
i) is that of a "gene-sign" laser and its solitonic electro-acoustic fields, such that the gene-biocomputer "reads and understands" these texts in a manner similar to human thinking, but at its own genomic level of "reasoning". It asserts that natural human texts (irrespectively of the language used), and genetic "texts" have similar mathematical-linguistic and entropic-statistic characteristics, where these concern the fractality of the distribution of the character frequency density in the natural and genetic texts, and where in case of genetic "texts", the characters are identified with the nucleotides, and
ii) that DNA molecules, conceived as a gene-sign continuum of any biosystem, are able to form holographic pre-images of biostructures and of the organism as a whole as a registry of dynamical "wave copies" or "matrixes", succeeding each other. This continuum is the measuring, calibrating field for constructing its biosystem.

Keywords: DNA, wave-biocomputer, genetic code, human language, quantum holography.

1. What Theory Predicts.

1.1 Introduction.

How did this new theory take shape? The principle problem of the creation of the genetic code, as seen in all the approaches [Gariaev 1994; Fatmi et al. 1990; Perez 1991: Clement et al. 1993; Marcer, Schempp 1996; Patel, 2000] was to explain the mechanism by means of which a third nucleotide in an encoding triplet, is selected. To understand, what kind of mechanism resolves this typically linguistic problem of removing homonym indefiniteness, it is necessary firstly to postulate a mechanism for the context-wave orientations of ribosomes in order to resolve the problem of a precise selection of amino acid during protein synthesis [Maslow, Gariaev 1994]. This requires that some general informational intermediator function with a very small capacity, within the process of convolution versus development of sign regulative patterns of the genome-biocomputer endogenous physical fields. It lead to the conceptualization of the genome's associative-holographic memory and its quantum nonlocality. These assumptions produce a chromosome apparatus and fast wave genetic information channels connecting the chromosomes of the separate cells of an organism into a holistic continuum, working as the biocomputer, where one of the field types produced by the chromosomes, are their radiations. This postulated capability of such "laser radiations" from chromosomes and DNA, as will be shown, has already been demonstrated experimentally in Moscow, by the Gariaev Group. Thus it seems the accepted notions about the genetic code must change fundamentally, and in doing so it will be not only be possible to create and understand DNA as a wave biocomputer, but to gain from nature a more fundamental understanding of what information [Marcer in press] really is! For the Gariaev Group's experiments in Moscow and Toronto say that the current understanding of genomic information i.e. the genetic code, is only half the story [Marcer this volume].

1.2 What experiment confirms, part one.

These wave approaches all require that the fundamental property of the chromosome apparatus is the nonlocality of the genetic information. In particular, quantum nonlocality/teleportation within the framework of concepts introduced by Einstein, Podolsky and Rosen (EPR) [Sudbery 1997; Bouwmeester et al.1997]. This quantum nonlocality has now, by the experimental work of the Gariaev Group, been directly related (i) to laser radiations from chromosomes, (ii) to the ability of the chromosome to gyrate the polarization plane of its own radiated and occluded photons and (iii) to the suspected ability of chromosomes, to transform their own genetic-sign laser radiations into broadband genetic-sign radio waves. In the latter case, the polarizations of chromosome laser photons are connected nonlocally and coherently to polarizations of radio waves. Partially, this was proved during experiments *in vitro*, when the DNA preparations interplaying with a laser beam (λ =632.8 nm), organized in a certain way,

polarize and convert the beam simultaneously into a radio-frequency range. In these experiments, another extremely relevant phenomenon was detected: photons, modulated within their polarization by molecules of the DNA preparation. These are found to be localized (or "recorded") in the form of a system of laser mirrors' heterogeneities. Further, this signal can "be read out" without any essential loss of the information (as theory predicts [Gariaev 1994; Marcer, Schempp 1996]), in the form of isomorphously (in relation to photons) polarized radio waves. Both the theoretical and experimental research on the convoluted condition of localized photons therefore testifies in favour of these propositions.

These independently research approaches also lead to the postulate, that the liquid crystal phases of the chromosome apparatus (the laser mirror analogues) can be considered as a fractal environment to store the localized photons, so as to create a coherent continuum of quantum-nonlocally distributed polarized radio wave genomic information. To a certain extent, this corresponds with the idea of the genome's quantum-nonlocality, postulated earlier, or to be precise, with a variation of it.

This variation says that the genetic wave information from DNA, recorded within the polarizations of connected photons, being quantum-nonlocal, constitutes a broadband radio wave spectrum correlated - by means of polarizations - with the photons. Here, the main information channel, at least in regard to DNA, is the parameter of polarization, which is nonlocal and is the same for both photons and the radio waves. A characteristic feature is, that the Fourier-image of the radio spectra is dynamic, depending essentially on the type of matter interrogated. It can therefore be asserted, that this phenomenon concerns a new type of a computer (and biocomputer) memory, and also a new type of EPR spectroscopy, namely one featuring photon-laser-radiowave polarization spectroscopy. **The fundamental notion is, that the photon-laser-radiowave features of different objects (i.e. the Fourier-spectra of the radiowaves of crystals, water, metals, DNA, etc) are stored for definite but varying times by means of laser mirrors, such that the "mirror spectra" concern chaotic attractors with a complex dynamic fractal dynamics, recurring in time.** The Gariaev Group experiments are therefore not only unique in themselves, they are a first example, that a novel static storage/recording environment (laser mirrors) exists, capable of directly recording the space-time atomic/molecular rotary dynamical behaviour of objects. Further the phenomena, detected by these experiments described in part two, establish the existence of an essentially new type of radio signal, where the information is encoded by polarizations of electromagnetic vectors. This will be the basis of a new type of video recording, and will create a new form of cinema as well.

Further experimental research has revealed the high biological (genetic) activity of such radio waves, when generated under the right conditions by DNA. For example, by means of such artificially produced DNA radiations, the super fast growth of potatoes (up to 1 cm per day) has been achieved, together with dramatic changes of morphogenesis resulting in the formation of small tubers not on rootstocks but on stalks. The same radiations also turned out to be able to cause a statistically authentic "resuscitation" of dead seeds of the plant *Arabidopsis thaliana*, which were taken from

the Chernobyl area in 1987. By contrast, the monitoring of irradiations by polarized radio waves, which do not carry information from the DNA, is observed to be biologically inactive. In this sequence of experiments, additional evidence was also obtained in favour of the possibility of the existence of the genetic information in form of the polarization of a radio wave physical field. This supports the supposition that the main information channel in these experiments is the biosign modulations of polarizations mediated by some version of quantum nonlocality. A well known fact can therefore be seen in new light, namely, that the information biomacromolecules - DNA, RNA and proteins - have an outspoken capacity to optical rotatory dispersion of visible light and of circular dichroism. Similarly, the low molecular components of biosystems, such as saccharides, nucleotides, amino acids, porphyrins and other biosubstances have the same capacity; a capacity, which until now made little biological sense. Now, however, it supports, the contention that this newly detected phenomenon of quantized optical activity can be considered as the means by which the organism obtains unlimited information on its own metabolism. That is, such information is read by endogenous laser radiations of chromosomes, which, in their turn, produce the regulative ("semantic") radio emission of the genome biocomputer. Furthermore, the apparent inconsistency between the wavelengths of such radiations and the sizes of organisms, cells and subcell structures is abrogated, since the semantic resonances in the biosystems' space are realized not at the wavelength level, but at the level of frequencies and angles of twist of the polarization modes. This mechanism is the basis for the artificial laser-radio-wave *vitro-in vivo* scanning of the organism and its components.

However, chromosome quantum nonlocality as a phenomenon of the genetic information is seen as particularly important in multicellular organisms and as applying on various levels.

The 1-st level is that the organism as a whole. Here nonlocality is reflected in the capacity for regeneration, such that any part of the body recreates the whole organism, as, for example, in case of the worm *Planaria*. That is to say, any local limiting of the genetic information to any part of a biosystem is totally absent. The same concerns the vegetative reproduction of plants.

The 2nd level is the cellular level. Here it is possible to grow a whole organism out of a single cell. However with highly evolved animal biosystems, this will be a complex matter.

The 3rd level is the cellular-nuclear level. The enucleation of nuclei from somatic and sexual cells and the subsequent introduction into them of other nuclei does not impede the development of a normal organism. Cloning of this kind has already been carried out on higher biosystems, for example, sheep.

The 4th level is the molecular level: here, the ribosome "would read" mRNA not only on the separate codons, but also on the whole and in consideration of context.

The 5th level is the chromosome-holographic: at this level, a gene has a holographic memory, which is typically distributed, associative, and nonlocal, where the holograms "are read" by electromagnetic or acoustic fields. These carry the gene-wave information out beyond the limits of the chromosome structure. Thus, at this and subsequent levels,

the nonlocality takes on its dualistic material-wave nature, as may also be true for the holographic memory of the cerebral cortex [Pribram 1991; Schempp 1992; 1993; Marcer, Schempp 1997; 1998]

The 6th level concerns the genome's quantum nonlocality. Up to the 6th level, the nonlocality of bio-information is realized within the space of an organism. The 6th level has, however, a special nature; not only because it is realized at a quantum level, but also because it works both throughout the space of a biosystem and in a biosystems own time frame. The billions of an organism's cells therefore "know" about each other instantaneously, allowing the cell set is to regulate and coordinate its metabolism and its own functions. Thus, nonlocality can be postulated to be the key factor explaining the astonishing evolutionary achievement of multicellular biosystems. This factor says that bioinformatic events, can be instantaneously coordinated, taking place "here and there simultaneously", and that in such situations the concept of "cause and effect" loses any sense. This is of a great importance! The intercellular diffusion of signal substances and of the nervous processes is far too inertial for this purpose. Even if it is conceded that intercellular transmissions take place electro-magnetically at light speeds, this would still be insufficient to explain how highly evolved, highly complex biosystems work in real time [Gariaev 1994; Ho 1993]. The apparatus of quantum nonlocality and holography is in authors' view, indispensable to a proper explanation of such real time working. The 6th level therefore says, the genes can act as quantum objects, and that, it is the phenomenon of quantum non-locality/teleportation, that ensures the organism's super coherency, information super redundancy, super knowledge, cohesion and, as a totality or whole, the organism's integrity (viability).

Indeed it can be said that this new understanding of biocomputers, constitutes a further step in a development of computer technology in general. An understanding that will bring about a total change of the constituent basis of that technology, in the history of analogue > to > digital > to > now, the figurative semantic (nonlocal) wave computer or biocomputer. This biocomputer will be based on new understanding of the higher forms of the DNA memory, and the chromosome apparatus, as the recording, storaging, transducing and transmitting system for genetic information, that must be considered simultaneously both at the level of matter and at the level of physical fields. The latter fields, having been just studied, as showed experimentally in this research, are carriers of genetic and general regulative information, operating on a continuum of genetic molecules (DNA, RNA, proteins, etc). Here, previously unknown types of memory (soliton, holographic, polarization) and also the DNA molecule, work both as biolasers and as a recording environment for these laser signals. The genetic code, considered from such a point of view, will be essentially different from today's generally accepted but incomplete model. This, the wave-biocomputer model asserts, only begins to explain the apparatus of protein biosynthesis of living organisms, providing an important interpretation for the initial stages within this new proposed composite hierarchic chain of material and field, sign, holographic, semiotic-semantic and, in the general case, of figurative encoding and deciphering chromosome functions. Here the DNA molecules, conceived as a gene-sign continuum of any biosystem, are able to form

pre-images of biostructures and of the organism as a whole as a registry of dynamical "wave copies" or "matrixes", succeeding each other. This continuum is the measuring, calibrating field for constructing any biosystem.

1.3 Features of the Wave Model

Adleman [1994], for example, has used the mechanism for fast and precise mutual recognition between the DNA anti-parallels half-chains to solve the "the travelling salesman's problem". However in the wave model of biosystems, this is only one aspect of the self-organization taking place. For here, as the experimental evidence now confirms, the mutual recognition of one DNA anti parallel half chain (+) by the other (-) concerns special super persistent/resonant acoustic-electromagnetic waves or solitons. Such DNA solitons have two connected types of memory. The first is typical of the phenomenon discovered by Fermi-Pasta-Ulam (FPU) [Fermi, 1972]. It concerns the capability of non-linear systems to remember initial modes of energisation and to periodically repeat them [Dubois 1992]. The DNA liquid crystals within the chromosome structure form such a non-linear system. The second is that of the DNA-continuum in an organism. Such memory is an aspect of the genome's nonlocality. It is quasi-holographic/fractal, and relates, as is the case for any hologram or fractal, to the fundamental property of biosystems i.e. to their ability to restore the whole out of a part. This property is well known (grafting of plants, regeneration of a lizard's tail, regeneration of a whole organism from the oocyte). And a higher form of such a biological memory would be a holographic (associative) memory of the brain cortex, i.e. of its neural network [Pribram 1991; Schempp 1992; Marcer Schempp 1997, 1998; Sutherland 1999]. Such wave sign encoding/decoding therefore, like DNA's ability to resolve "the travelling salesman's problem", is, it can be hypothesized, an integral part of DNA's computational biofunctionality. Indeed DNA solitary waves (solitons), and in particular, the nucleotide waves of oscillatory rotation, "read" the genome's sign patterns, so that such sign vibratory dynamics may be considered as one of many genomic non-linear dynamic semiotic processes. The expression "DNA's texts", borrowed earlier as a metaphor from the linguists, is it turns out therefore related directly to actual human speech. For as mathematical-linguistic research into DNA and human speech textual patterns, shows [Maslow, Gariaev 1994] the key parameter of both such patterns is fractality. It can therefore be hypothesized that the grammar of genetic texts is a special case of the general grammar of all human languages.

Returning however to DNA computation based on matter-wave sign functions with a view to realizing its wave coding capabilities, as distinct those used by Adleman, which might be termed its matter capabilities. Such true wave control capabilities of the DNA or chromosomes are, we hypothesize, those conditions that apply inside the living cell, i.e. in an aqueous solution but which correspond to a liquid-crystal condition as well. For under such conditions, in the unique circumstances of cell division, the living cell has the ability to replicate itself, and has the property of what in relation to a self replicating automaton, von Neumann [1966] called "universal computer construction"

so that we may say that the living cell is such a computer based on DNA [Marcer Schempp 1997a]. And while the artificial cloning of a single cell is not yet feasible, what we have been able to do, is to record the DNA-wave information appropriate to these wave sign conditions of the DNA in a cell on laser mirrors, and to use, for example, the recorded DNA-wave information from living seeds in the form of radio waves to resuscitate the corresponding "dead" seeds damaged by radioactivity.

The next step forward is therefore to bring into general use, such wave information and memory as now newly identified in relation to DNA and gene structure. Such applications could be on the basis of, for example,

i) The FPU-recurrence phenomenon, and/or,

ii) The ability to record holograms, as well as,

iii) The recording the polarization-wave DNA's information onto localized photons.

Regarding volume and speed, such memory could exceed many times over the now available magnetic and optical disks, as well as current classical holographic systems. But in particular, such applications may employ the principles of quantum nonlocality. For DNA and the genome have now been identified as active "laser-like" environments, where, as experimentally shown, chromosome preparations may act as a memory and as "lasers", with the abilities i), ii) and iii) above. And finally there are the quasi-speech features of the DNA, as these concern both natural gene texts, and artificial (synthesized) sign sequences of polynucleotides, which emulate natural quasi-speech gene programs. However, we believe this maybe a rather dangerous path, where a regulatory system of prohibitions on artificial wave genes is indispensable. The reason is that such an approach to DNA-wave biocomputation means entering new semiotic areas of the human genome and the biosphere in general; areas, which are used by the Nature to create humankind. This thought follows from the theoretical studies on a collective symmetry of the genetic code as carried out by the Eigen's laboratory [Scherbak, 1988] at the Max Planck Institute in Germany. This research shows, that the key part of the information, already recorded and still being recorded as quasi-speech in the chromosomes of all organisms on our planet, may concern semantic exobiological influences, since in regard to DNA-wave biocomputation, DNA acts as a kind of aerial open to the reception of not only the internal influences and changes within the organism but to those outside it as well. Indeed we regard this as one of our primary findings, which in view of quantum nonlocality of organisms extends not only to the organism's local environment, but also beyond it to the extent of the entire universe.

With reference to what we have said already, it is possible to offer the following perspectives on the sign manipulations with gene structures.

1.Creation of artificial memory on genetic molecules, which will indeed possess both fantastic volume and speed.

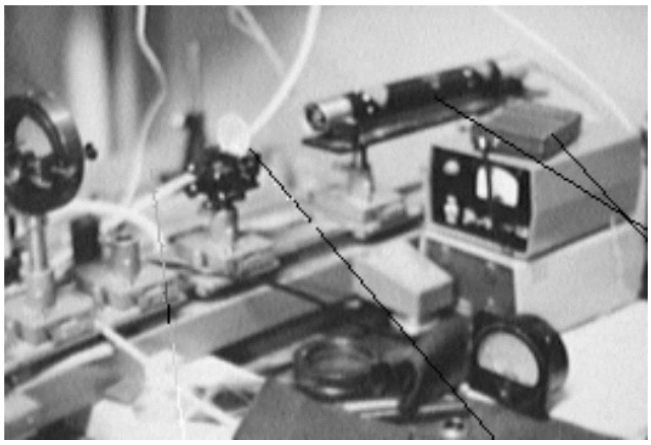
2.Creation of biocomputers, based on these totally new principles of DNA-wave biocomputation, which use quantum teleportation [Sudbury 1997] and can be compared to the human brain regarding methods of data processing and functional capabilities.

3.The implementation of a remote monitoring of key information processes inside biosystems by means of such artificial biocomputers, resulting in treatments for cancer,

AIDS, genetic deformities, control over socio-genetic processes and eventually prolongation of the human life time.
4.Active protection against destructive wave effects, thanks to wave-information channel detectors.
5.Establishing exobiological contacts.

2. What Experiment Confirms, part two, the Experiments

Some of the experiments and computer simulations carried out in Moscow are now described. They set out in more detail how the understanding in sections 1. was arrived at. These descriptions concern the specific apparatus used and results obtained, together with computer simulations carried out to validate specific aspects of the developing understanding,



Photograph 1. This first picture shows a photograph of the experimental apparatus. The principal elements are a laser, the light of which is directed through a lens system and a DNA sandwich sample as shown diagrammatically below

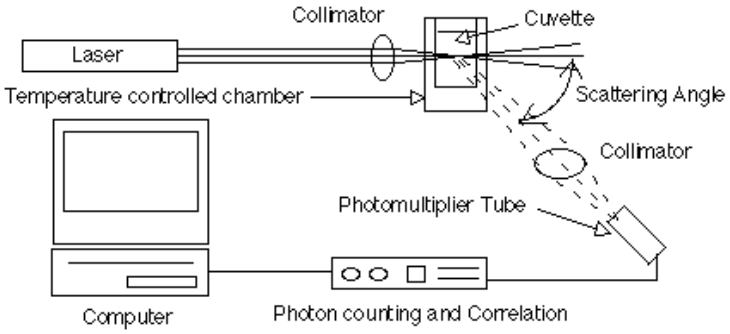
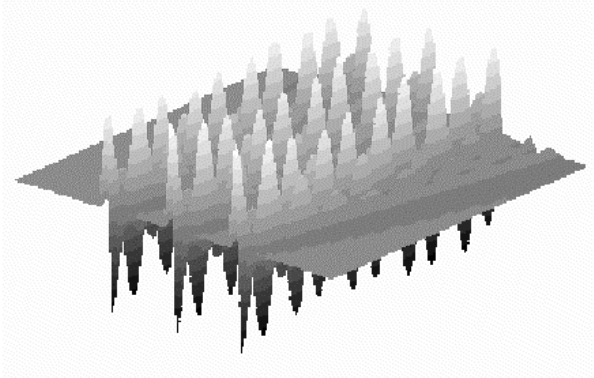


Diagram 1. Illustrates the workings of the experiment which employs a dynamic light scattering system of the type Malvern.
This understanding is then compared in section 3 with an entirely independently researched prospective obtained by Marcer, and Schempp [1996].

This shows the scattering by the DNA sample of the laser light, which is then guided through another lens system into the type Malvern analysing device, which counts the photons registered in different serial channels.The results of two experiments are shown at end of paper: the first entitled "Background - Empty Space", done without a DNA sample, and the second, with it in place, entitled "Physical DNA in SSC Solution".
The latter has the typical form of a periodically reoccurring pattern, which is of the same functional type as found in an autocorrelation. Such regularly occurring periodic patterns have an interpretation in terms of the phenomenon of so-called Fermi-Pasta-Ulam recurrence, which concerns solitonic waves. That is to say, this interpretation says that roughly speaking, the DNA, considered as a liquid-crystal gel-like state, acts on the incoming light in the manner of a solitonic Fermi-Pasta-Ulam lattice, as illustrated here:



.
The leading question, if this is the case, is what could such action achieve? The starting idea was that it must be concerned with the reading of the genetic texts encoded in the DNA, where however this language metaphor is now applied directly to these texts. That is to say, rather than the usual analogy taking such texts as a digital computer language or symbolic instruction code, such texts are considered instead as having the semantic and generative grammatical features of a spoken or written context dependent human language. That is, we conceived of the DNA acting in the same way as the human would, when presented with a text from a good book on a fascinating theme, which, as it is read, invokes actual 3 dimensional pictures/images in the mind's eye.
The reason for this choice concerned the problem in DNA coding raised by the question of synonymy and homonymy as it applies to the third element/codon of the codon triplets. For while, see figure below, synonymy even seems to provide a kind of redundancy, homonymy constitutes a serious difficulty under the often proposed postulate that only the first two elements of the DNA codon triplet (standing for a particular protein- the picture in the mind's eye, so to speak) are the significant ones. That is to say, how does the reading ribosome know which protein has to be generated, if the third nucleotide in codon's triplet does not of itself provide the answer with total certainty? The proposed answer was, that this ambiguity might be resolved by some kind of context dependent reading similar to that inherent in human speech and language understanding.

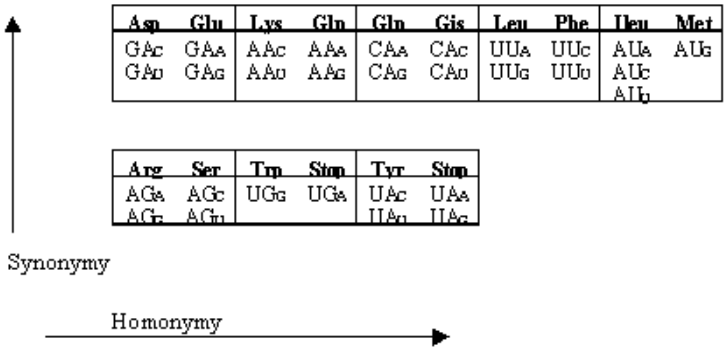
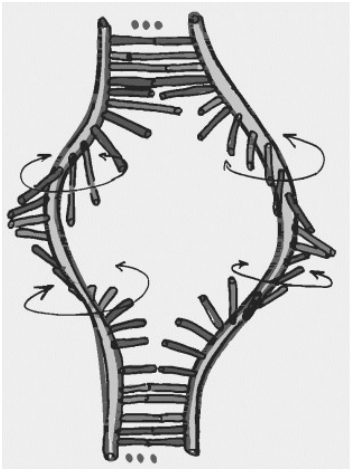


Figure: Synonymy versus Homonymy

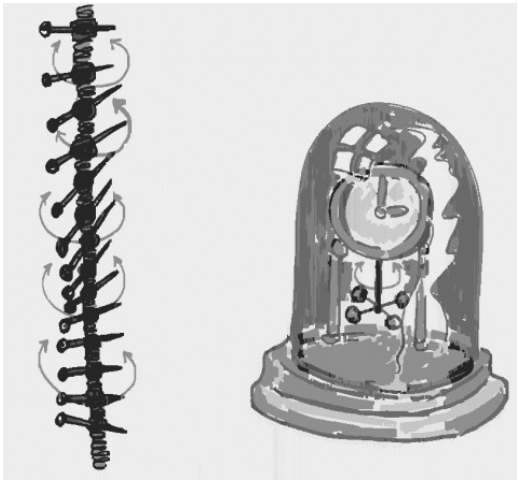
Satisfyingly, this need to explain how such context-dependent reading might be implemented in the DNA reduplication/reading process, as will be shown, led back to the experimental evidence as presented above, for it supports the postulate that such context dependent reading of the DNA is indeed best understood in the framework of a biosolitonic process model.

A soliton is an ultra stable wave train often with a seemly simple closed shape, which can arise in the context of non-linear wave oscillations. It actually consists of a rather complexly interrelated assembly of sub wave structures, which keep the whole solitonic process in a stationary state over a comparatively long time. In the literature, a soliton is often described as an entity, which is neither a particle nor a wave in much the same way as is a quantum, for it, too has wave/particle duality. It can also be a means to carry information. Solitonic processing in DNA, would therefore, it was hypothesized, relate, in one of its aspects, the reading of the codons, to quantum computing [Patel 2000], and this could therefore concern the soliton viewed as the travelling "window", that opens in the double helix structure as the reading takes place, as is illustrated below:



It was therefore decided to model this reading process as a complex mechanical oscillator [Gariaev 1994], capable of producing solitonic wave transmissions, which

takes the form of a system of rotary pendulums, like those in a certain type of pendulum clock, as illustrated,

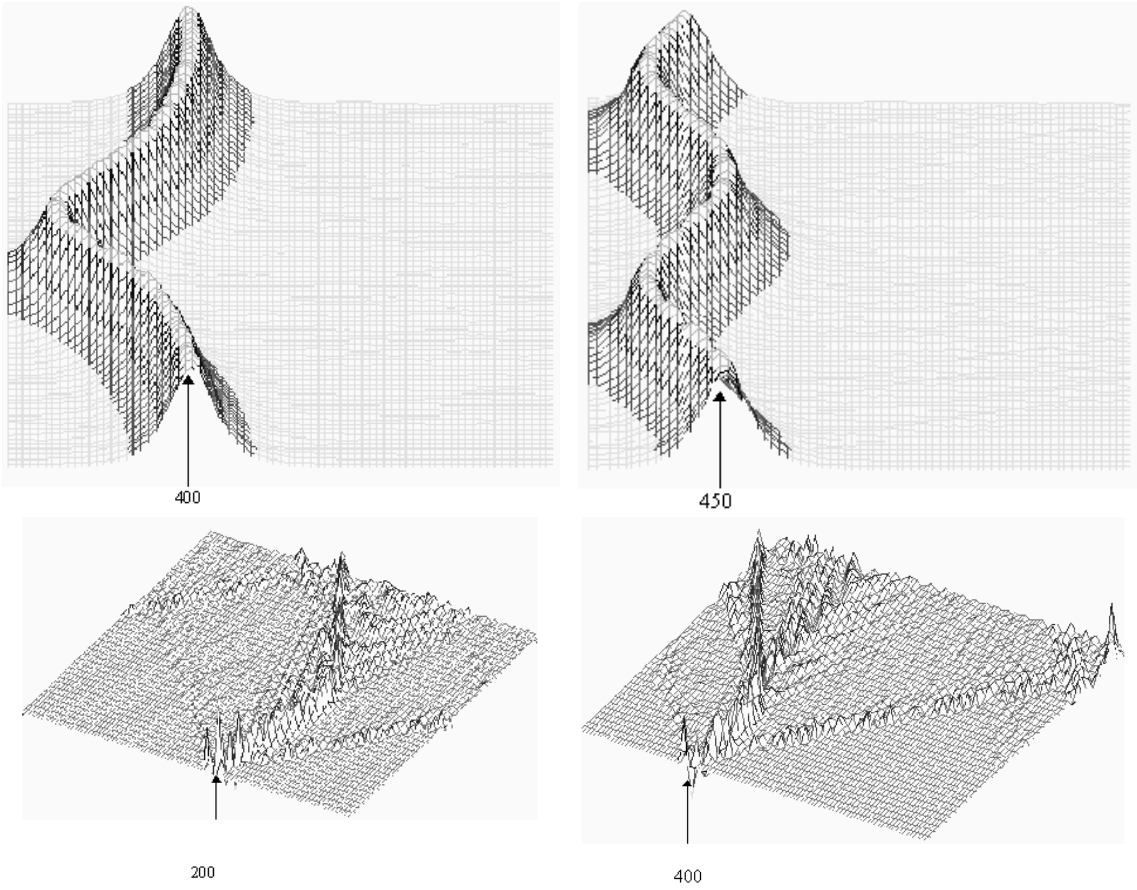


to see if the computer simulations could shed more light on just what might be happening in the DNA. In the basic model, illustrated and shown below, each of the oscillatory movements of each element of the linked chain of oscillators depends heavily on the motion of its neighbours, and on the differences in the specific weights of the elements. Imagine now that the DNA forms such a kind of pendulum, whilst the intertwined helices/chains are opened at one particular section to provide the travelling window, as in the previous figure. That is to say, the model to be simulated is a chain of non-linear oscillators, the four types of which can be identified with the Adenine (A), Cytosine (C), Guanine (G), and Thymine (T) or Uracil (C) components DNA, all having different spatial structures and masses, and where there is a travelling window opened in the double helix. Such a model allows a rather complex pattern of oscillation in the DNA chain of elements, depending on the actual layout of the elements as specified by the actual genetic code sequence involved. The window as it travels, is therefore highly context dependent.
Starting at the following sequence:

(5′˜ начало) ⇒ GGC CTA TGT GGA GAG GAT GAA CTA CGT GCA CCG AGA CCT GCG GGC GGC CAA CAT
CCT GGT GGG GGA GAA CCT GGT GTG CAA GGT GGC TGA CTT TGG GCT GGC ACG CCT CAT CGA GGA CAA
CGA GTA CAC AGC ACG GCA AGG TGC AAG TTC CCC ATC AAG TGG AGA GCC CCC GAG GCA GCC CTC TAT
GGC CGG TTC ACC ATC AAG TCG GAT GTC TGG TCC TTC GGC ATC CTG CTG ACT GAG CTG ACC ACC AAG
GGC CGG GTG CCA TAC CCA GGG ATG GGC AAC GGG GAG GTG CTG GAC CGG GTG GAG AGG GGC TAC CGC
ATG CCC TGC CCG CCC GAG TGC CCC GAG TCG CTG CAT GAC CTT ATG TGC CAG TGC TGG CGG AGG GAC
CCT GGA GGA GCG GCC CAC TTT TCG AGC TAC CTG CAG GCC CAG CTG CTC CCT GCT TGT GTG TTG GAG
GTC GCT GAG TAG TGC GCG AGT AAA ATT TAA GCT ACA ACA AGG CAA GGC TTG ACC GAC AAT TGC ATG
AAG AAT CTG CTT AGG GTT AGG CGT TTT GCG CTG CTT CGC GAT GTA CGG GCC AGA TAT ACG CGT ATC
TGA GGG GAC TAG GGT GTG TTT AGG CGA AAA GCG GGG CTT CGG TTG TAC GCG GTT AGG AGT CCC CTC
AGG ATA TAG TAG TTT CGC TTT TGC ATA GGG AGG GGG AAA TGT AGT CTT ATG CAA TAC TCT TGT AGT
CTT GCA ACA TGG TAA CGA TGA GTT AGC AAC ATA CCT TAC AAG GAG AGA AAA AGC ACC GTG CAT GCC
GAT TGG TGG AAG TAA GGT GTA CGA TCG TGC CTT ATT AGG AAG GCA ACA GAC CGG GTC TGA CAT GGA
TTG GAC GAA CCA CTG AAT TCC GCA TCG CAG AGA TAT TGT ATT TAA GTG CCT AGC TCG ATA CAA TAA
ACG CCA TTT GAC CAT TCA CCA CAT TGG TGT GCA CCT GGG TTG ATG GCT GGA CCG TCG ATT CCC TAA
CGA TTG CGA ACA CCT GAA TGA AGC AGA AGG CTT CAT ⇐ **1020** (3′-конец)

the figures, which follow, are those of the computer simulation of this process of the travelling window, carried out in relation to a particular fragment of viral DNA. The

first two figures with respect to the simulation, where the vertical is the time axis, show what would happen, in case of a context dependent reading beginning from two different nucleotides of the DNA chain, namely the 400th and the 450th respectively. In both cases these concern activity in the form of a "kink", which runs through the chain of nucleotides, A, C, G, T. The second two figures show even more sophisticated types of context dependent effects. These concern the complex dynamic patterns, which arise when also taking into account the non-linear covalent connections between the nucleotides.



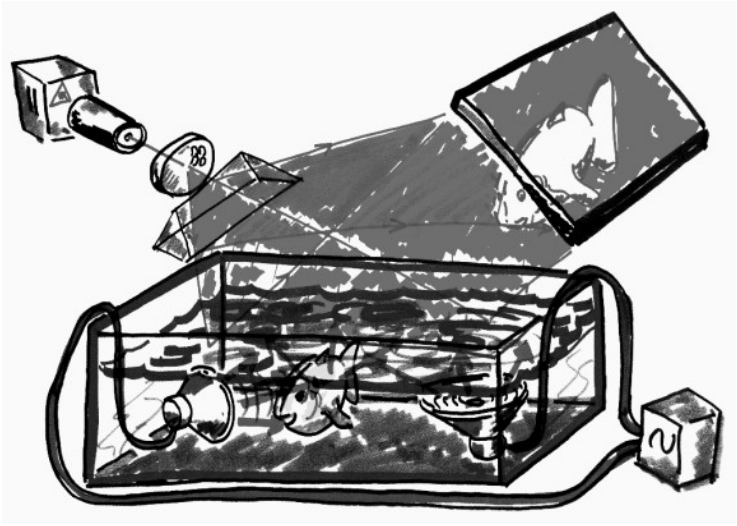
-

Thus subject to the assumption that DNA is a certain kind of liquid crystal structure with dynamic properties, where the interrelated solitonic activities are linked, as may be supposed, together to form a highly coherent wave structure, then:-

i) The masses of the nucleotides and other parameters show that these oscillatory activities should be located somewhere together in the "acoustic" wave domain, and

ii) That, as a liquid crystal, the DNA could influence the polarization of the weak light emission known to exist in cells, the so called "biophotons". This kind of emitted light in cells was first discovered by the Russian investigator Alexander Gurwitsch [1923], who called it the "mitogenic radiation". Today it is known from the work of Fritz Albert Popp [Popp, 2000], that such biophotonic or mitogenic light, while being ultraweak, is

however on the other hand, highly coherent, so that it has an inherent laser-like light quality.
The experimental setting and the resulting simulations therefore say that:-
iii) The experimental laser beam is simply a substitute for the endogenous intracellular coherent light emitted by the DNA molecule itself, and that
iv) The superimposed coherent waves of different types in the cells are interacting to form diffraction patterns, firstly in the "acoustic" domain, and secondly in the electromagnetic domain. Furthermore such diffraction patterns are by definition (and as is known for example from magnetic resonance imaging (MRI) [Binz, Schempp 2000a,b] a kind of quantum hologram. Thus, it seems that our original picture is confirmed and that the considered interaction between solitonic oscillations in the liquid crystal structure of DNA, and the polarization vector of the ultraweak biophotonic highly coherent light, could indeed be hypothetically understood as a mechanism of translation between holograms in the "acoustic" frequency domain, which concerns rather short range effects and those in the electromagnetic domain and vice versa.
The basis of such an hypothetical mechanism as a translation process, between acoustic and optical holograms, can be easily illustrated in the laboratory, where, as shown below, there is a fish illuminated in water by means of the acoustic radiation, in such a way that on the surface of the water an interference pattern or hologram forms, such that when this interference pattern is illuminated from above in the right way, by light of a high laser quality, a virtual visual image of the fish appears above the water. It shows that the hologram in question acts as a holographic transducer between the acoustic and electromagnetic domains.



Laboratory illustration of a holographic transducer between the acoustic and electromagnetic domains.

This illustrated transduction when described in terms of the formalization of Huygens' principle of secondary sources [Jessel 1954], has been used as the basis of a new topological computing principle [Fatmi, Resconi 1988] which defines entire classes of

non-commutative control structures, Fatmi et al [1990]. It was applied to DNA. and more recently to the brain [Clement et al. 1999].

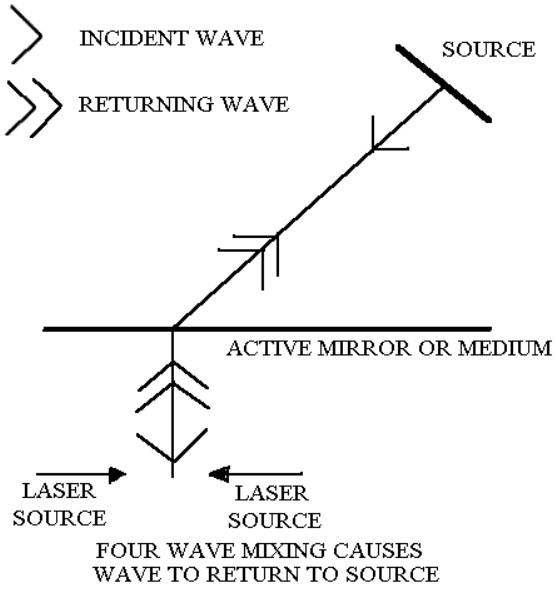
3. Another Theoretical but Experimentally Validated Perspective - Quantum Holography

Sections 1 and 2 are in excellent agreement with the independently researched model of DNA produced by Marcer and Schempp [1996]. This explains the workings of the DNA-wave biocomputer in terms of a quantum mechanical theory called *quantum holography* [Schempp 1992] used by Schempp [1998] and Binz and Schempp [2000a,b; 1999] to correctly predict the workings of MRI. These two DNA-wave biocomputer models are also, as cited, in good agreement with qubit model explanation of DNA more recently published by Patel [2000], and earlier independent researched models by Clement et al [1993] and Perez [1991].

The *quantum holographic* DNA-wave biocomputer model describes the morphology and dynamics of DNA, as a self-calibrating antenna working by phase conjugate adaptive resonance capable of both receiving and transmitting quantum holographic information stored in the form of diffraction patterns (which in MRI can be shown to be *quantum holograms*). The model describes how during the development of the embryo of the DNA's organism, these holographic patterns carry the essential holographic information necessary for that development. This would explain the almost miraculous way the multiplying assembly of individual cells is coordinated across the entire organism throughout every stage of its development - in complete agreement with the explanation arrived at in Moscow by Gariaev and his co-workers

The *quantum holographic* theory requires that the DNA consists of two antiparallel (phase conjugate) helices, between which (in conformity with DNA's known structure, ie the planes on which the base pairing takes place) the theory says, are located hologram planes/holographic gratings, where the necessary 3 spatial dimensional holographic image data of the organism is stored in agreement with the Gariaev group's hypothesis. It says, as described in relation to laser illumination of a DNA sample, that such illumination can be expected to turn the DNA into a series of active adaptive phase conjugate mirrors (see figure below)/holographic transducers (see figure of laboratory illustration earlier), from which would resonantly emerge a beam of radiation, on which is carried the holographic information as encoded in the DNA. As indeed is the case in the Gariaev group experiments already described. These experiments thus confirm the *quantum holographic* prediction that DNA functions an antenna capable of both encoding and decoding holographic information. This functionality is also in good agreement with the findings of Schempp [1986] that *quantum holography* is capable of modelling antennae such as synthetic aperture radars, and that this mathematical description of radar can be applied [Marcer and Schempp 1997] to a model, working by *quantum holography*, of the neuron. This model is in good accord with the biological neuron's information processing morphology and signal

dynamics. As indeed are the *quantum holographic* models of the brain as a conscious system, and of the prokaryote cell [Marcer, Schempp 1996, 1997a]. It is a viewpoint originally voiced by de Broglie, who presciently pictured the electron as being guided by its own pilot wave or radar! These examples including MRI all demonstrate that *quantum holography* does indeed incorporate signal theory into quantum physics and it can be hypothesized biocomputation.



Phase conjugate mechanism or mirror in the laboratory.
Action of an active adaptive phase conjugate mirror.

Furthermore, *quantum holography* predicts that the planes, in which the base pairing takes place, constitute a "paged" associative holographic memory and filter bank (carrying holograms which can be written and read) and which has no cross talk between the pages. The orthogonality of the holograms encoded on these pages, arises as the result of the sharp frequency adaptive coupling conditions (1), which specify very narrow spectral windows, i.e. the "pages".

(1) $\langle Hv(a,b; x,y)|\ Hv(c,d\ ;\ x,y)\rangle = 0$ when frequency v is not equal v'
$\langle Hv(a,b; x,y)|\ Hv(c,d\ ;\ x,y)\rangle = \langle aOb\ |\ cOd\rangle$ when v = v'

for non-degenerate four wavelet mixing where a,b,c,d are the corresponding wave functions of the mixing; Hv(a,b; x,y) is the holographic transform which in *quantum holography* defines the probability of detecting a wave quantum frequency v within a unit area attached to the point (x,y) of the hologram plane, where the wavelet mixing aOb takes place and is described in terms of a tensor multiplication O. The orthogonality condition (1) can be seen therefore as specifying a set of diagonal

elements or trace Tr in a unit matrix in the frequency domain. It implies, as can be shown, that the Shannon encoding schema employed in DNA is optimally efficient, which following a billion or more years of evolution, in DNA could be expected to be the case.

The conditions (1) are therefore in excellent agreement with Gariaev group's conclusion. It confirms that the planes on which the base pairing takes places, concerns two quantum holograms, ie the wavelet mixings aOb and cOd, where each specifies a "context", one for the other. Further *quantum holography* predicts, based on the symmetries of the 3 dimensional representation of the Heisenberg Lie group G, that in relation to the quantum hologram defined by a wavelet mixing aOb, the coherent wavelet packet densities a(t)dt and b(t')dt' are indistinguishable by means of relative time and phase corrections applied to the respective wavelet pathways (x,y) in the hologram plane. That is, to say, the tensor operation O, in the case of *quantum holography,* describes a quantum entanglement, even though aOb defines a quantum hologram, from which *quantum holography* shows and MRI proves, holographic information can be both written/encoded and read/decoded.

Thus, mathematically, DNA can on the basis of *quantum holography* be thought of represented quantum mechanically very simply by the trace

$Tr < a,b \mid c,d >$

such that when the double helix is opened, in accordance with the Gariaev description above, this corresponds to the representation

$< a,b \mid >< \mid c,d >$

The process of completed duplication of DNA can therefore represented as

$Tr<a,b \mid c,d>< a,b \mid c,d >$

because as it is crucial to understand in the case of DNA, the two strands of the double helix are, *quantum holography* shows, not the same but phase conjugate, ie what biologists call complementary/antiparallel, and so must be represented within the context of DNA itself by a,b and c,d respectively. These pairs differ *quantum holography* shows, constituting covariant and contragrediant representations, which are essentially topologically cohomologous [Marcer 2000]. It could explain why to quote de Duve [1984], just the two elementary base-pairing {A,U/T}and {G,C} of respectively the nucleotides Adenine and Uracil/Thymine together with Guanine and Cytosine, are needed, to "govern through the two relatively fragile structures they embody, the whole of information transfer throughout the biosphere". That is to say, in DNA, these two nucleotide base pairings are the universal chemical mechanisms producing the wavelet mixing O on the hologram planes (which they also define) such that DNA can then be given a shorthand description in terms of context dependent genetic texts written in the four letters A,T,G,C.

The topological differentiation referred to above follows from the fact that, while in quantum mechanics, a wave function is only determined up to an arbitrary phase, phase difference is of physical significance (as in holography), because there exists a class of quantum observables, which are the gauge invariant geometric phases of the state vector or wave function [Resta 1997; Schempp 1992; Anandan 1992]. These observables must

therefore be distinguished from those which are the eigenvalues of some operator, usually the Hamiltonian or energy function. Such a state vector description (with gauge invariant phases) by means of which each DNA molecule can clearly be expected to be described, would explain the difference between the nature of quantum interference and quantum self interference, which DNA from its double helical structure can thus be recognized to concern.

In the above means of representing DNA therefore, | >< | represents by the quantum correspondence principle, the quantum soliton control [see also, Denschlag et al, 2000] or wavepacket activity rather than its classical soliton counterpart, which was the subject of the Moscow computer simulations. These all confirm the Gariaev group's conclusions reached as a result of their experiments, that DNA functions as a quantum coherent system/assembly (of now quantum oscillators) or whole, by means of quantum entanglement. A whole, where as (1) shows, this may be decomposed into an orthogonal family of holographically encoded 3 spatial dimensional images in line with the usual description of a quantum mechanical diagonalization. It also says in line with the Gariaev group's findings that DNA can be described as an "autocorrelation", where as shown here, this is an optimally efficient decomposition into a decorrelated family of holographic code primitives /holograms, and that this, as Schempp[1992] shows, follows from the fact a quantum mechanical harmonic oscillator (in this case the highly complex DNA molecule itself) is equivalent to an assembly of bosons each having one polarization state. The latter substantiates the Gariaev group conclusion that they have indeed discovered an entirely new form of electromagnetic vector by means of which holographic images are carried in the form of a polarization state, suitable for a new form of cinema, video and computer.

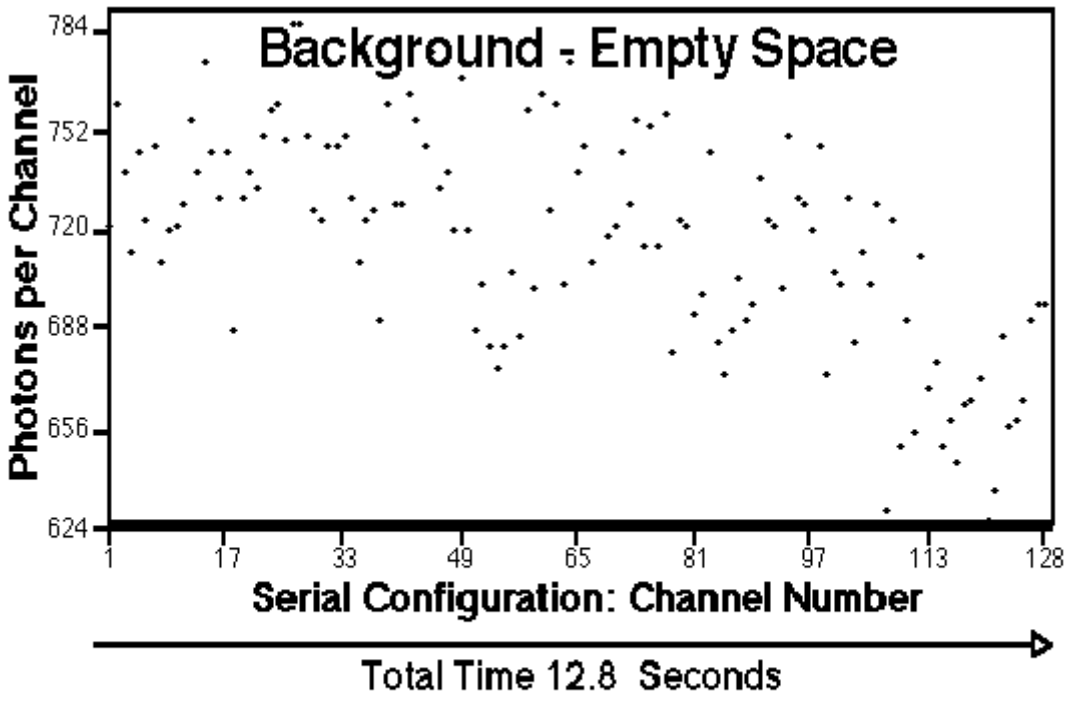
Quantum holography says that DNA satisfies the principle of computer construction [Von Neumann, 1966], since it carries a copy of itself, and is

(a) its own blueprint written in the genetic texts, where the mechanism engineering the DNA replication is the biophotonic electromagnetic field, while the "letters" of the genetic texts A, G, C, U are held invariant, but where,

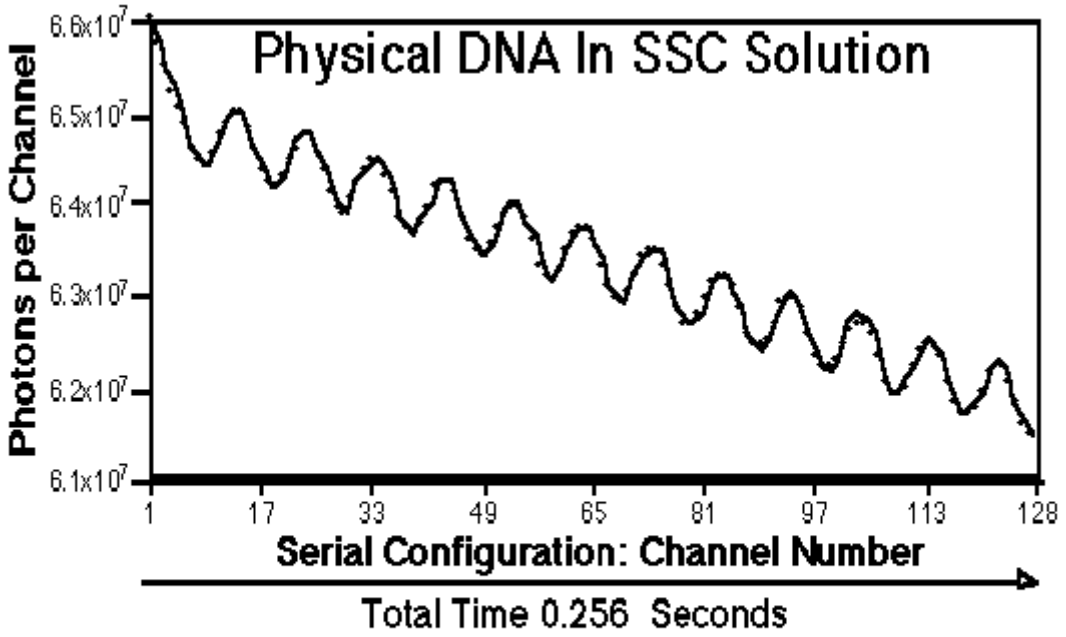
(b) in the case of the replication of the organism, for which DNA is the blueprint written in the holographic information, the reverse is the case. That is, it is the "acoustic field" in this case, which mechanically constructs/engineers the organism out of the available matter, in accordance with the information held in the electromagnetic field holograms (these being held invariant in this case). This must therefore mean that Adenine, Uracil, Guanine, and Cytosine are invariants structures/weightings in both the acoustic and electromagnetic field domains. These mechanisms therefore correspond with the know basic features of quantum communication/information transfer known as quantum teleportation, which consists of two inseparable signal processes one classical, one quantum. The latter is instantaneous transmission from X to Y (unlimited in principle as to distance), but which cannot be used without the other, which is transmission from X to Y by conventional means at the speed of light or lower. In the case of DNA, therefore, it is the existence of the genetic text of the organism itself which constitutes the classical signal process of quantum teleportation, able to facilitate the quantum

mechanical signal processes of both the copying of the DNA as its own blueprint, and of the construction of the organism (for which DNA is the blueprint) in a massively parallel way by the means of quantum teleportation.

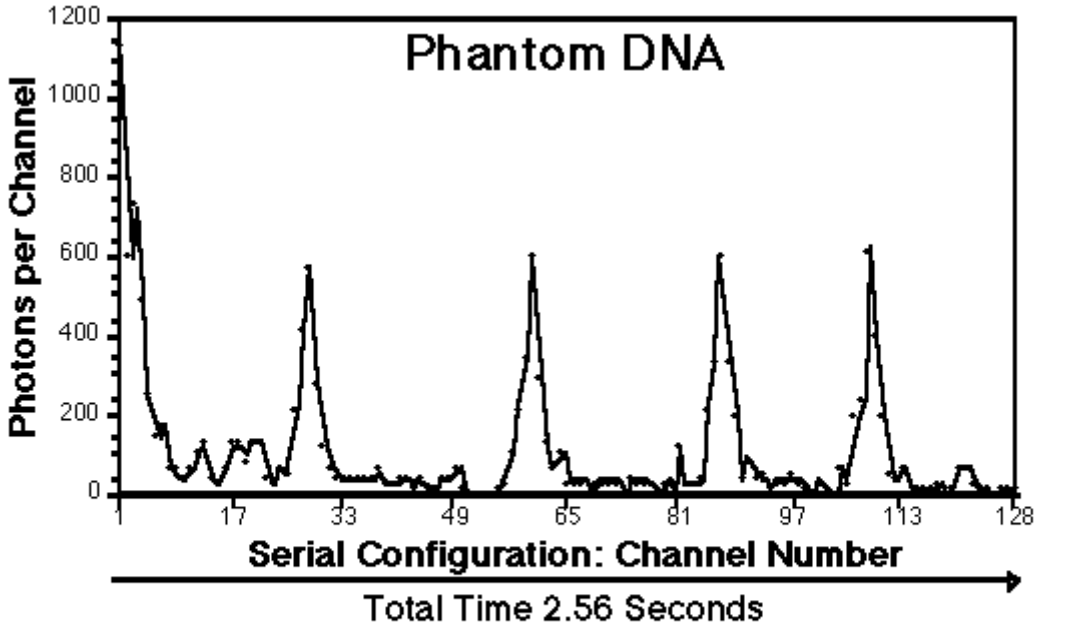
Remarkably too, *quantum holography* also confirms and is confirmed by another astonishing experimental finding. This is the so-called "DNA-Phantom-Effect" [Gariaev, Junin, 1989; Gariaev et al, 1991; Gariaev, 1994], a very intriguing phenomenon, widely discussed, when it was first found by Peter Gariaev. Later similar phenomenon termed “mimicking the effect of dust” [Allison et al, 1990]. was detected by group of R.Pecora. This is the discovery that the pattern below, found in the first experiment described, when a laser illuminated DNA, does not immediately disappear if the DNA samples are removed from the apparatus. It continues in different form for sometime. An explanation would be that *quantum holography* defines an admitter/absorber quantum vacuum model of quantum mechanics in terms of annihilation/creation operators [Schempp 1993], implying that DNA does indeed behave like a single quantum, which induces a "hole" temporarily in the vacuum by its removal.



(a)



(b) MALVERN <<< K7032 >>> Version 2.1 Date 14-12-1990 Time 12:25:07
Correlator 1 Sample Time per Channel (mS) = 2.0
Auto-correlation



(c) MALVERN <<< K7032 >>> Version 2.1 Date 23-11-1992 Time 13:37:28
Correlator 1 Sample Time per Channel (mS) = 20
Auto-correlation

Graphs (a),(b) and (c): "Background - Empty Space", Physical DNA in SSC Solution" and "Phantom DNA" respectively

References

Adleman L.M. 1994, Molecular Computation of Solutions to Combinatorial Problems, Science, 266, 11th November 1021-1024.

Allison S.A., Sorlie S., Pecora R., 1990, Macromolecules, v.23, 1110-1118.

Anandan J. 1992, The geometric phase, Nature, 360, 26, 307-313

Binz E. Schempp W. 2000a Creating Magnetic Resonance Images, Proceedings CASYS'99, International Journal of Computing Anticipatory Systems, 7, 223-232.

Binz E. Schempp W. 2000b, A Unitary Parallel Filter Bank Approach to Magnetic Resonance Tomography, American Institute of Physics Proceedings 517 of the 3rd International Conference on Computing Anticipatory System, editor Dubois D. August 9-14, 1999, Liege, Belgium, 406-416.

Binz E., Schempp W. 1999, Quantum Teleportation and Spin Echo, Unitary Symplectic Spinor Approach. In. Aspects of Complex Analysis, Differential Geometry, Mathematical Physics and Applications, Dimiev S. Sekigawa K. editors, World Scientific, 314-365.

Bouwmeester D. et al., 1997, Experimental Quantum Teleportation, Nature, 390, 11th December 575-579

Clement B.E.P. Coveney P.V. Marcer P. 1993, Surreal numbers and optimal encodings for universal computation as a physical process: an interpretation of the genetic code. CCAI Journal, 10, 1/2, 149-164.

Clement B.E.P. Coveney P.V, Jessel M. and Marcer P. 1999, The Brain as a Huygens' Machine. Informatica 23, 389-398.

Denschlag J. et al, 2000, Generating Solitons by Phase Engineering of a Bose-Einstein Condensate, Science, 287, 7th January, 97-101

Dubois D., 1992, The Fractal Machine, Liege University Press, Liege.

de Duve C. 1984 A Guide Tour of the Living Cell, volume two, Scientific American Library,

Fatmi H.A. and Resconi G. 1988, A New Computing Principle, Il Nuovo Cimento, 101B, 2, 239-242.

Fatmi H.A., Jessel M., Marcer P.and Resconi G. 1990, Theory of Cybernetic and Intelligent Machine based on Lie Commutator. International Journal of General Systems, 16, 123-164.

Fermi E., 1972, Proceedings. Moscow. Science. v.11.

Gariaev P.P., Junin A.M., 1989, Energy, no10, 46-52. [in Russian]

Gariaev P.P., Chudin V.I., Komissarov G.G., Berezin A.A., Vasiliev A.A., 1991, Proc. SPIE, v.1621, 280-291.

Gariaev P.P, 1994, Wave genome, Public Profit. Moscow. 279 pages [in Russian].

Gurwitsch A., 1923, Versuch einer synthetishen Biologie. Schaxels Abh. Z. theor. Biol. H. 17.

Ho M-W, 1993, The Rainbow and the Worm: The Physics of Organisms, World Scientific, Singapore.

Jessel M. 1954, Une formulation analytique du principe de Huygens, Comptes Rendus,

239, 1599-1601.
Marcer P. 1992, Designing New Intelligent Machines - The Huygens' Machine, CCAI Journal for the Integrated Study of Artificial Intelligence and Applied Epistemology, 9,4, 373-392. 4, 373-392.
Marcer P. 2000, Hypercomputation, Third International Conference on Computing Anticipatory Systems, CASYS '99, Liege, Symposium 9 on Quantum Neural Information Processing, Journal of Computing Anticipatory Systems, ed. Dubois D., vol. 7, 288-312.
Marcer P. this volume, Quantum Millennium, Quantum Universe, Quantum Biosphere, Quantum Man.
Marcer P. (in press) Anticipation and Meaning, CASYS 2000, International Conference on Computing Anticipatory Systems, AIP Conference Proceedings, ed Dubois D.
Marcer P. and Schempp W., 1996, A Mathematically Specified Template For DNA And The Genetic Code, In Terms Of The Physically Realizable Processes Of Quantum Holography, Proceedings of the Greenwich Symposium on Living Computers, editors Fedorec A. and Marcer P., 45-62.
Marcer P., Schempp W. 1997, Model of the Neuron working by Quantum Holography, Informatica 21, 5 19-534.
Marcer P and Schempp W., 1997a, The Model of the Prokaryote cell as an Anticipatory System Working by Quantum Holography, Proceedings of CASYS 97, 11-15, August, HEC-Liege, Belgium, International Journal of Computing Anticipatory Systems, v.2, 307-315.
Marcer P., Schempp W. 1998, The brain as a conscious system, International Journal of General Systems, 27, 1/3, 231-248.
Maslow M.U., Gariaev P.P., Fractal Presentation of Natural Language Texts and Genetic Code, 2nd International Conference on Quantitative Linguistics", QUALICO '94, Moscow, September 20-24, 193-194, 1994
Patel A. 2000, Quantum Algorithms and the Genetic Code, Proceedings of the Winter Institute of Quantum Theory and Quantum Optics, 1-13 January, S.N. Bose National Centre for Basic Sciences, Calcutta, India.
Perez J-C, 1991, De l'ordre et du chaos dans l'ADN, Science et Technology, April, 36, 40-47.
Pribram K.H. 1991, Brain and Perception; Holonomy and Structure in Figural Processing, Lawrence Eribaum Associates, New Jersey.
Popp F.A., 2000, Some features of biophotons and their interpretation in terms of coherent states. Biophotonics and Coherent Systems. Proc. 2nd A.Gurwitsch Conference and Additional Contributions. Moscow University Press. Ed. L.Beloussov et al., 117-133.
Resta R., 1997, Polarization as a Berry Phase,(The Berry Phase), Europhysics News, 28,19
Rice S.A. 1992, New Ideas for Guiding the Evolution of a Quantum System, Science, 258, 16th October, 412-413.
Schempp W. 1986, Harmonic Analysis on the Heisenberg Group with Applications in

Signal Theory, Pitman Notes in Mathematics Series, 14, Longman Scientific and Technical, London.
Schempp W. 1992, Quantum holography and Neurocomputer Architectures, Journal of Mathematical Imaging and Vision, 2, 279-326.
Schempp W., 1993, Bohr's Indeterminacy Principle In Quantum Holography, Self-adaptive Neural Network Architectures, Cortical Self-organization, Molecular Computers, Magnetic Resonance Imaging and Solitonic Nanotechnology, Nanobiology 2, 109-164.
Schempp W. 1998, Magnetic Resonance Imaging, Mathematical Foundations and Applications, John Wiley, New York.
Scherbak V.I., 1988, J. Theor. Biol., v.132, 121-124.
Schleich W.P. 1999, Sculpting a Wavepacket, Nature, 397, 21st January, 207-208.
Sudbery T. 1997, The Fastest Way from A to B., Nature, 390, 11th December,551-552
Sutherland J. 1999, Holographic/Quantum Neural Technology, Systems and Applications, an ANDCorporation documented plenary presentation for the 3rd International Conference on Computing Anticipatory Systems, 8-14 August, HEC Liege, Belgium. International Journal of Computing Anticipatory System, 2000, 7, 313-334, sutherland@andcorporation.com. and http://www.andcorporation.com.
Von Neumann J. 1966, Theory of A Self-reproducing Automaton, University of Illinois Press, Urbana and London.