Aquaphotomics Winter Webinar

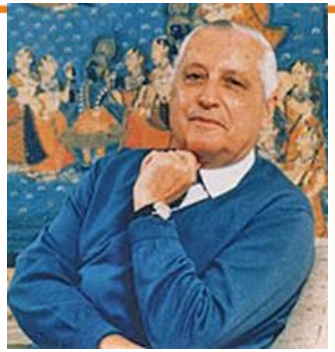
Coherence in water as a negentropic engine

Livio Giuliani [1,2]

Time & Date: 2024/02/27 (Tuesday)
Starts at: Japan Time (GMT) 5:00 PM
Central European Time (CET) 9:00 AM
Ends at: Japan Time (GMT) 6:00 PM
Central European Time (CET) 10:00 AM

[1] **ECERI** (European Cancer and Environment Research Institute) - Scientific Committee, Bruxelles (B)
[2] **ICEMS-CIRPS** (International Commission for Electromagnetic Safety- Interuniversitary Center for Research on Sustainable Development), Valmontone (I)

One of the paradoxes attributed to Ilya Prigogine can be formulated equivalently as a question:
WHY CHEMICAL REACTIONS IN LIVING ORGANISMS REQUIRE LESS ENERGY THAN IN INDUSTRIAL REACTORS?
Or else:
WHO PROVIDES MISSING ENERGY TO LIVING SYSTEMS FOR THEYR OWN CHEMICAL REACTIONS?



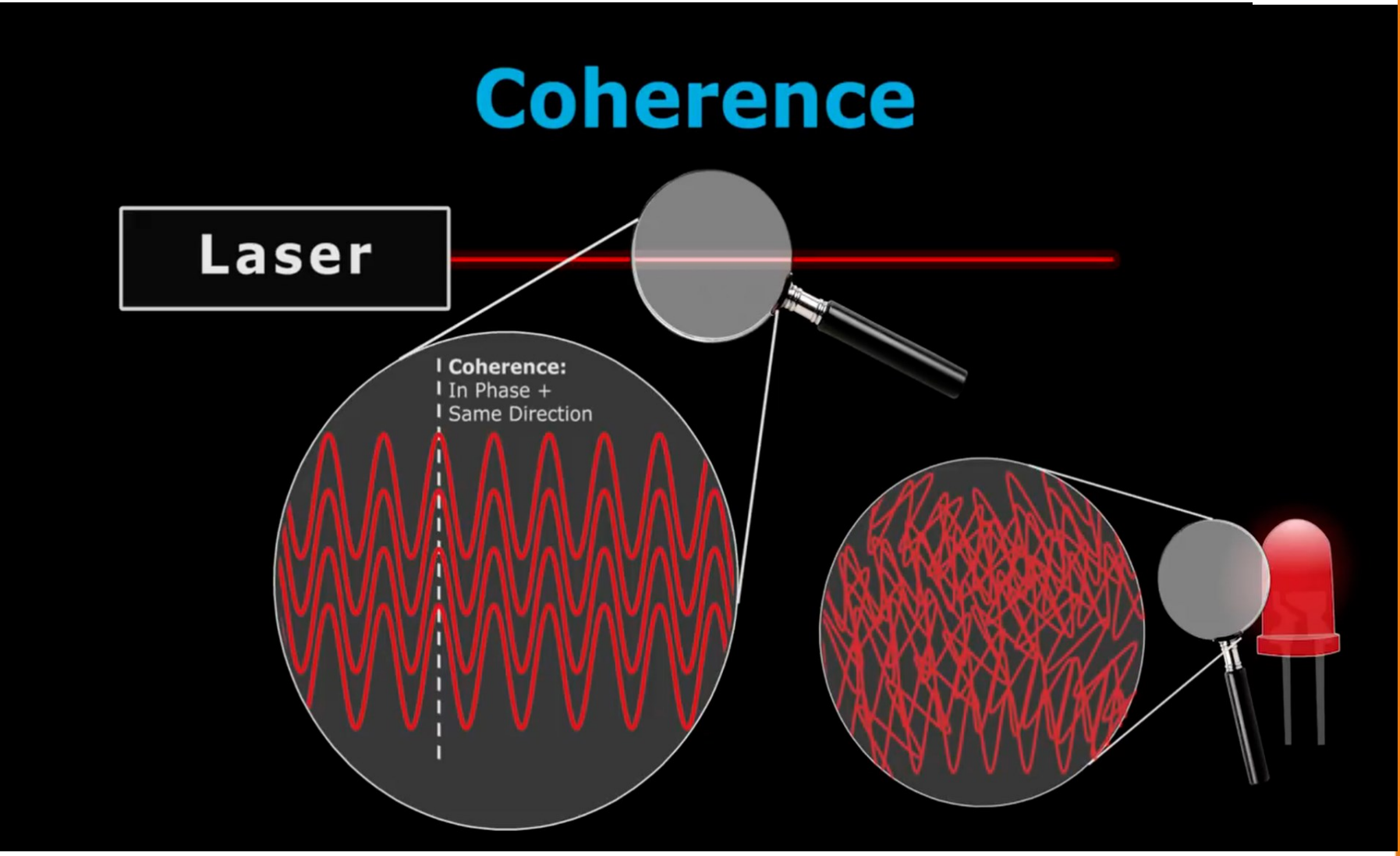
Ilya Prigogine

Giuliano Preparata and Emilio Del Giudice, up

A early answer came in 1988, thank to Italian Theoretical Physicists [1], who compared water to a free electric dipole laser, stating that liquid water is a biphasic liquid: a mix of molecules at two different levels of energy. This theory was further developed [2] and, in 1995, G. Preparata published a Quantum Electrodynamics essay [3], providing a full theory of quantum molecular physics of liquid water: it is a BIPHASIC *liquid and one of the two phases is a COHERENT phase. In which, coherent clusters of water molecules are dynamically defined since they are arising and dissolving forming a phase which compenetrates the opposite, incoherent phase, made of neutral molecules or hydrate ions, each one moving in a disordered way.*

Twenty years later than the theoretical prediction [1], clusters of water molecules were observed by Huang C. et al. (2009) [4] and confirmed indipendently by Taschin et al. (2013) [5]

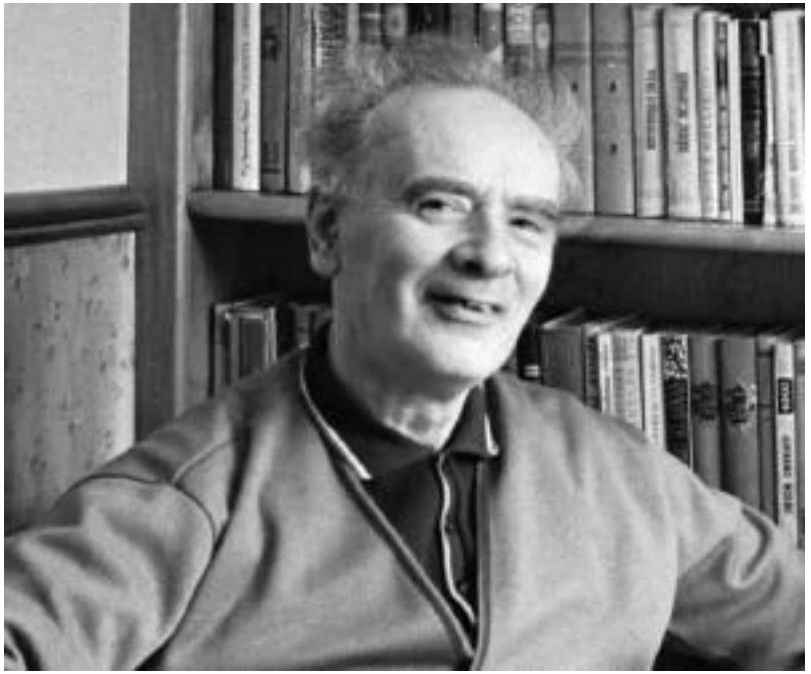
Coherence In Radiation



COHERENCE WAS DISCOVERED IN HERTZIAN WAVES

by A. Kastler, in *1950*, who proposed the laser as an optical pump, earning the Nobel Prize in 1966.

In *1962* L.D. Landau earned his Nobel Prize with the discovery of coherence in the superfluid state of He-4



In *1988* E Del Giudice, G Preparata and G Vitiello theorized the similarity of water and free electron lasers, which implied the existence of coherence in water at lab pressure and temperature.

Coherence in Water at Room Temperature

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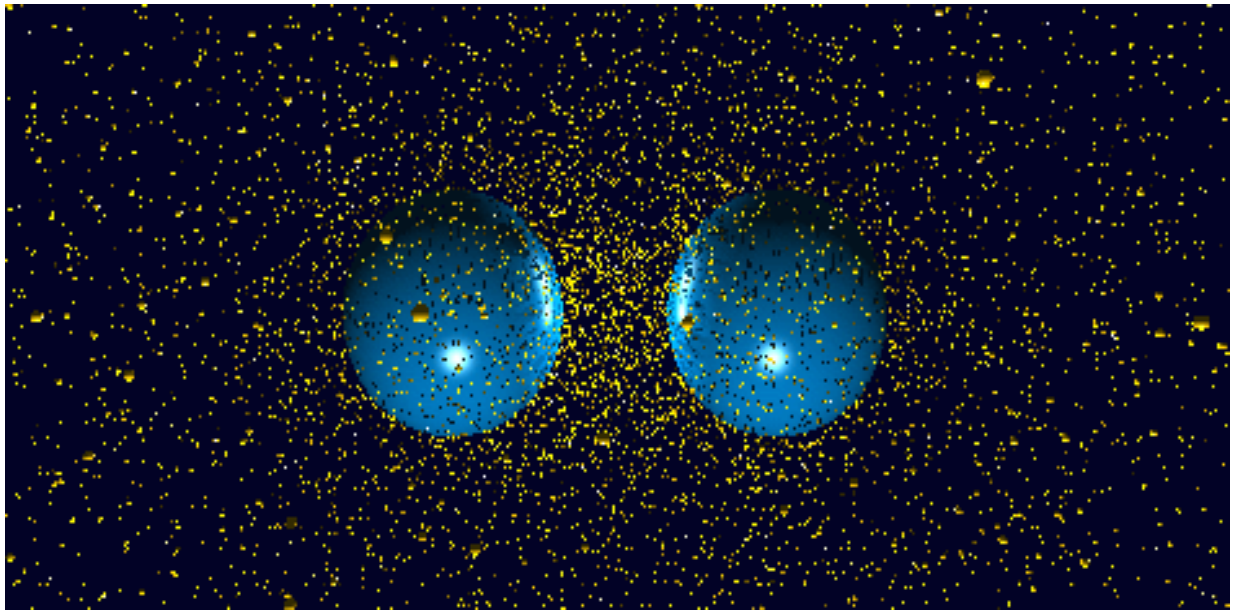
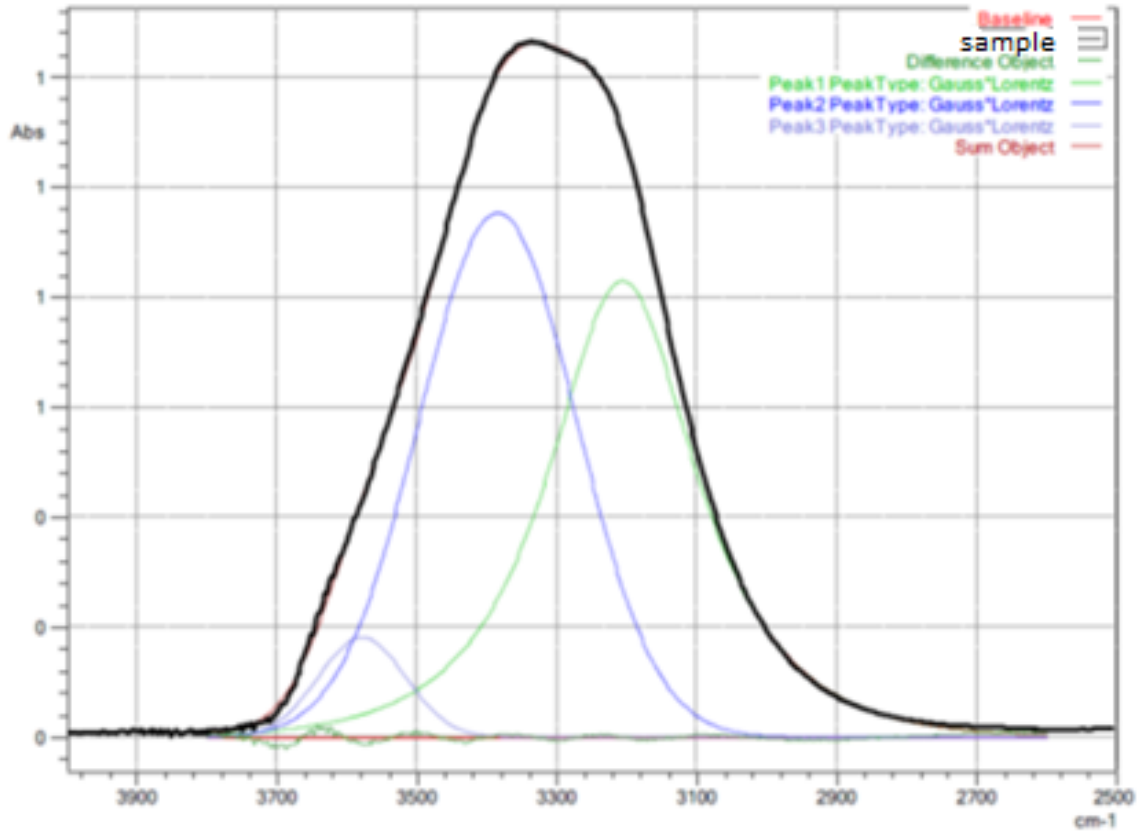
Water at room temperature and pressure can be considered as a dynamic equilibrium between water single molecules and water clusters organized as mesoscopic aggregates:
clusters molecules are tuned in phase i.e. clusters are coherent



A public artistic image

Since clusters are coherent they may be named Coherence Domains (CDs)

Measurement of *coherence* in water



As De Ninno A. and A. Congiu Castellano showed (2010, [6]), FTIR provides a way to test the degree of coherence of water at room pressure and temperature, in agreement with the computed average value in [3].

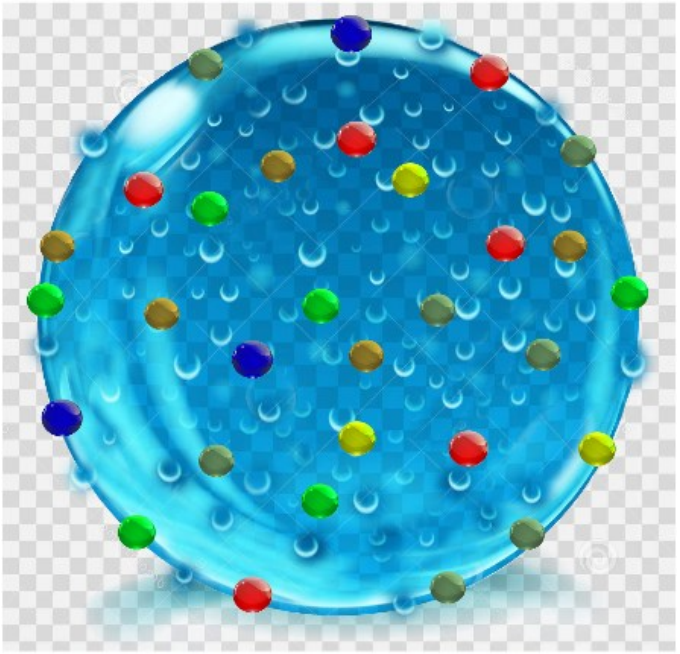
Fig. 1

In fig. 1, the absorpiton peak of water, related to oscillation of O-H bond and sited in the range 2650-3750 cm^{-1} is deconvoluted in 3 peaks, The one at lower energy is relatable with molecules of the coherent fraction since coherence is the state with lower internal energy. The one at higher energy is relatable to non coherent water and the intermediate peak to the integration of all flickering aggregates between single molecules and coherent domain.

Coherence in Water

It is only thank to the Novikov-Zhadin experiment (NZe) that we can understand how water is storing energy and information. Thus we discovered the existence of Mixed Water Coherent Domains (MWCDs), clusters of water molecules and ions tuned in phase

Once Abe Liboff said: only cations are responsive to the ion cyclotron resonance. As a matter of fact I never saw anions move under the Liboff- or Zhadin- effect



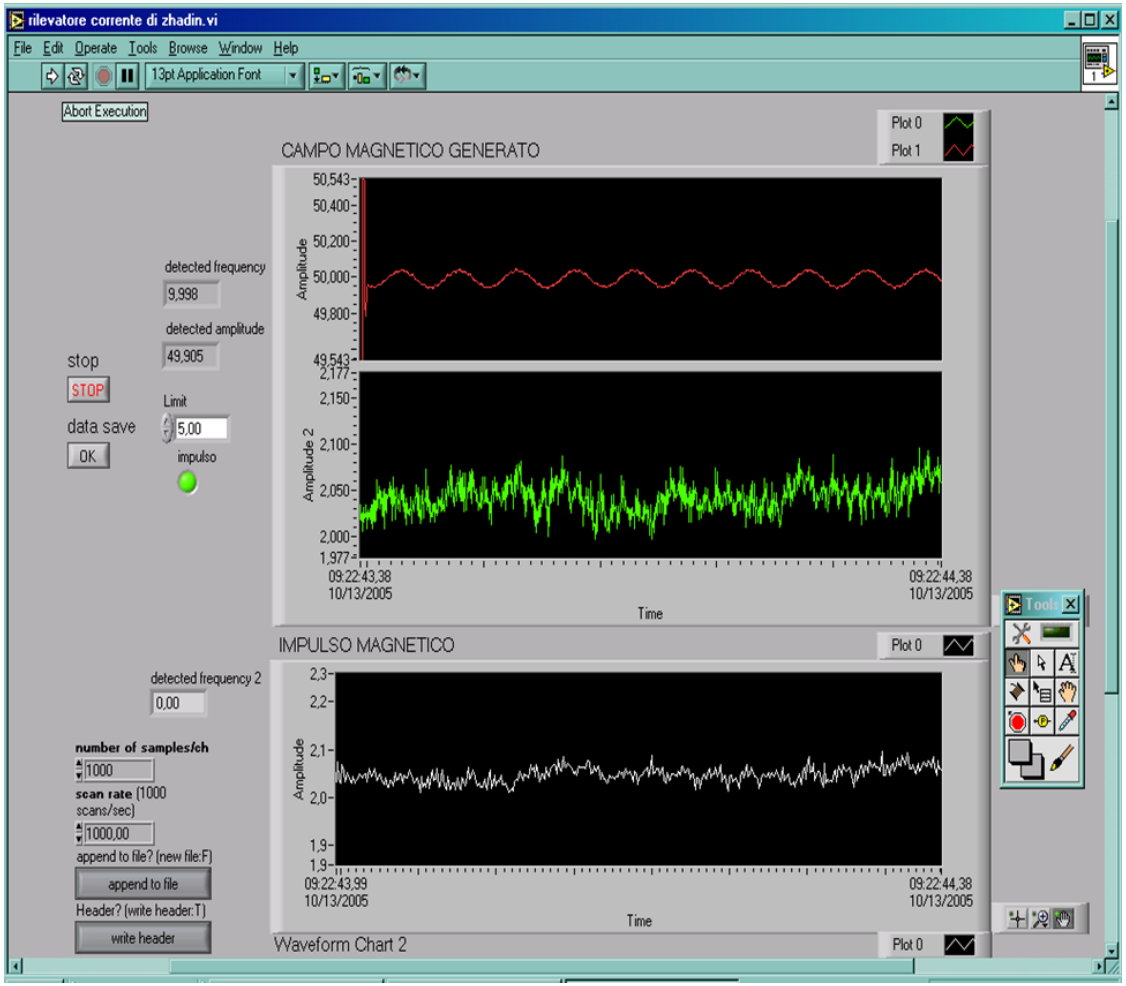
An artistic image
Credit to Grafimax by M. Paolini

Anions are solvated in bulk water according to their hydration number (less or more) [6b]

In the picture, coloured balls are cations where water molecules, white underlined, can be distinguished, as well, in the CD-surface

Novikov-Zhadin Experiment Replication in Rome

Fig. 2 - Replication of the Zhadin experiment at the CNR facility at Tor Vergata, Rome, (Ion Cyclotron Resonance of Glutamic Acid), 2004-15.

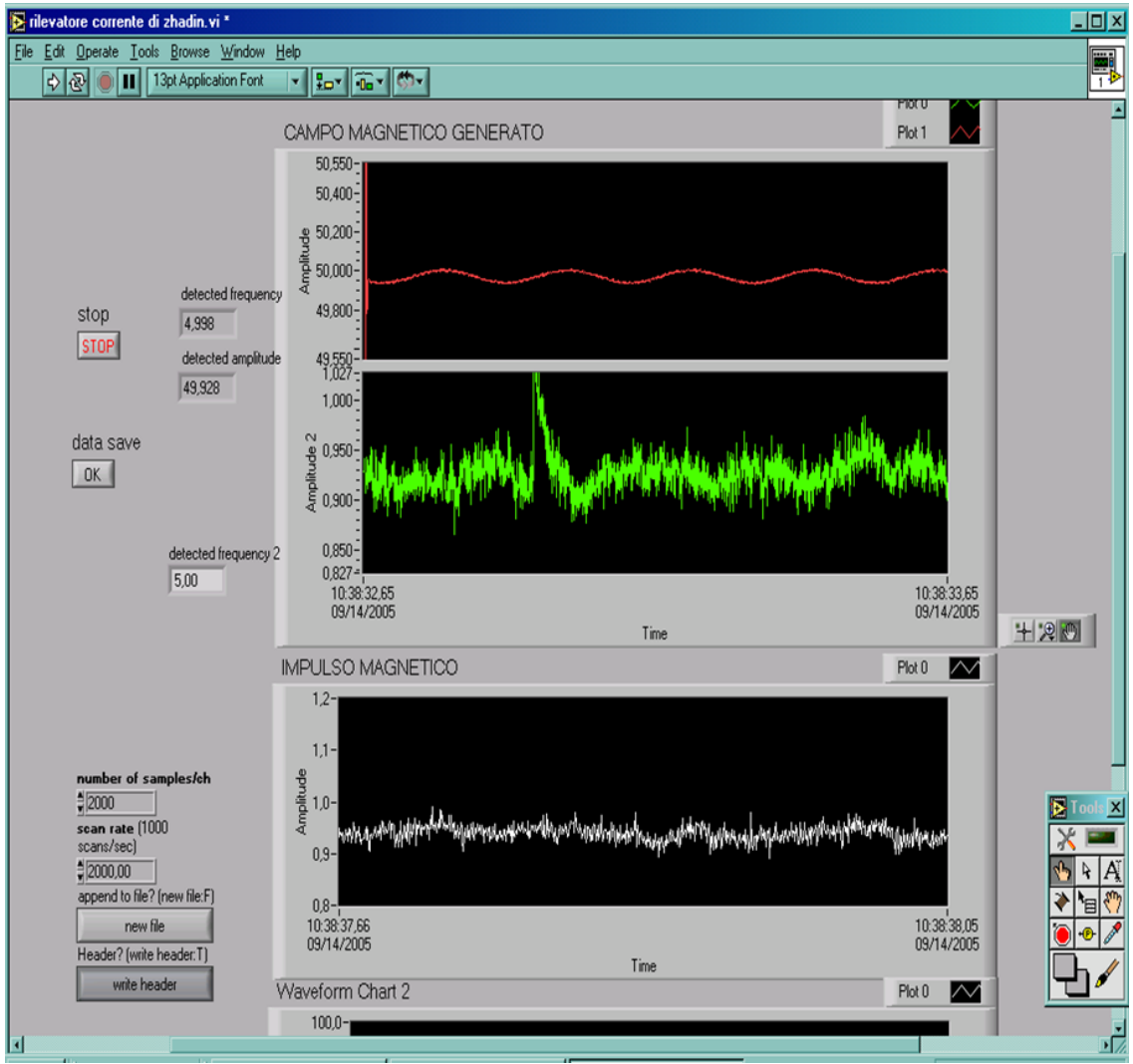


Settimio Grimaldi

Noise without signals

Novikov-Zhadin Experiment: Replication in Rome

Fig. 2 bis - Replication of the Zhadin experiment at the CNR facility at Tor Vergata (Ion Cyclotron Resonance of Glutammic Acid - Glu), 2004-15.

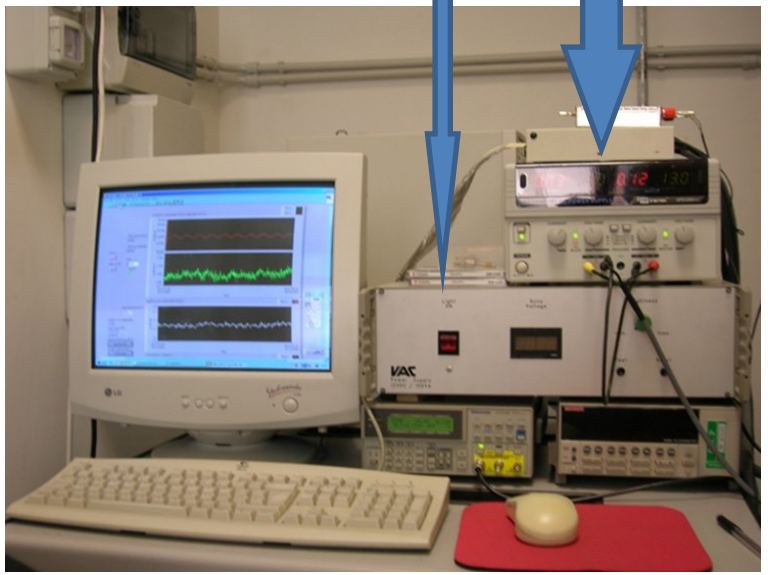


In an electrolytic cell, filled with an aqueous solution, with electrodes linked through a conductor without supply, when an AC MF is applied (5 Hz tuned with 0,02 mT DC MF) a signal arises (middle panel). Signal is due to an ion current of the solute chemical specie, which is sensitive to ion cyclotron resonance (in the case ICR of GLU).

Novikov-Zhadin Experiment: Replication in Rome

In 2000 years the *Zhadin experiment* had been replicated in other independent laboratories in Frascati (2002) [10, Annex C], in Muenchen (2004) [11],in Legnaro (Padoa 2006) [15], in Turin, in Rome(2008) [12,18].

A remotely controlled solenoid-incubator within the hypomagnetic room of CNR in Rome:
the signal generator and the CO_2 and Temperature Control Unit



Novikov-Zhadin experiment: Replication in Kgs. Lymby (DK)

DTUavisen NR. 3·2015

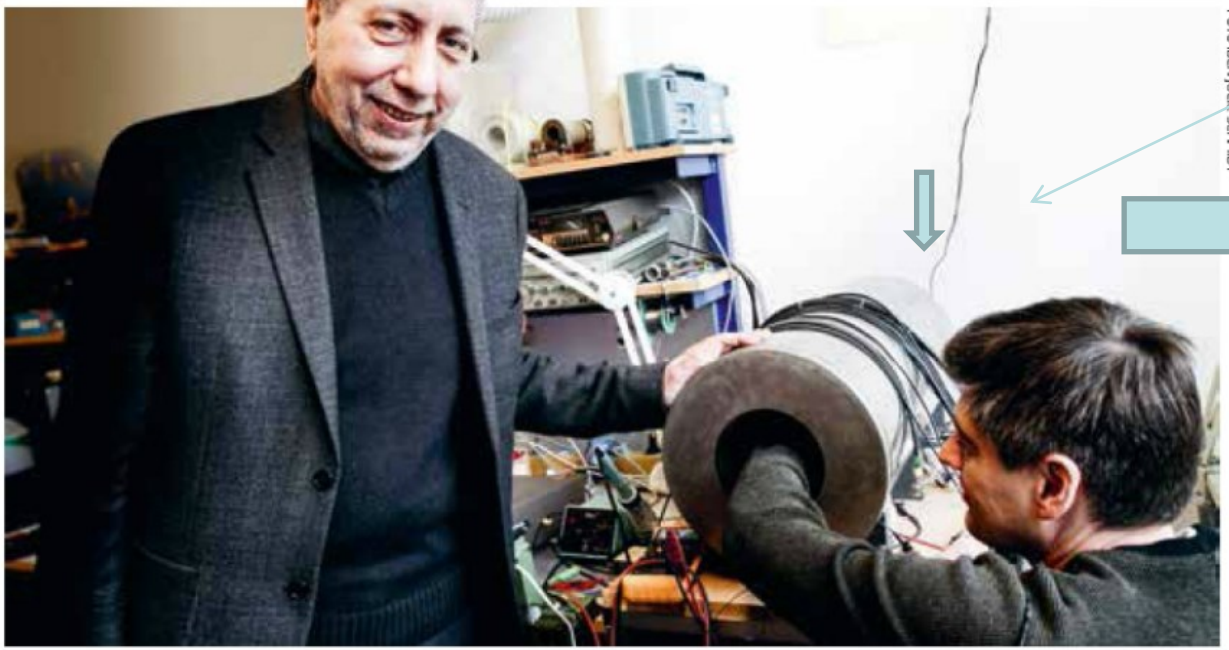


FOTO IBEN JULE SCHMIDT

Professor Livio Giuliani (tv.) og Nikolaj Blom ved en forsøgsopstilling på DTU Nanotech.
Professor Livio Giuliani (left) and Nikolaj Blom at a test set-up at DTU Nanotech.

μ-Metal Tube of the Space Institute at DTU, K.Lymby allows almost «zero-field», inside

Ny teori om vand kan revolutionere biologien

PARADIGMESKIFT En italiensk forsker, som netop har været gæsteprofessor på DTU, hævder, at vand har skjulte egenskaber, som kan få stor betydning for bl.a. kræftbehandlingen.

Liboff's Experiment at Kgs. Lymby (DK) 2015 Jan

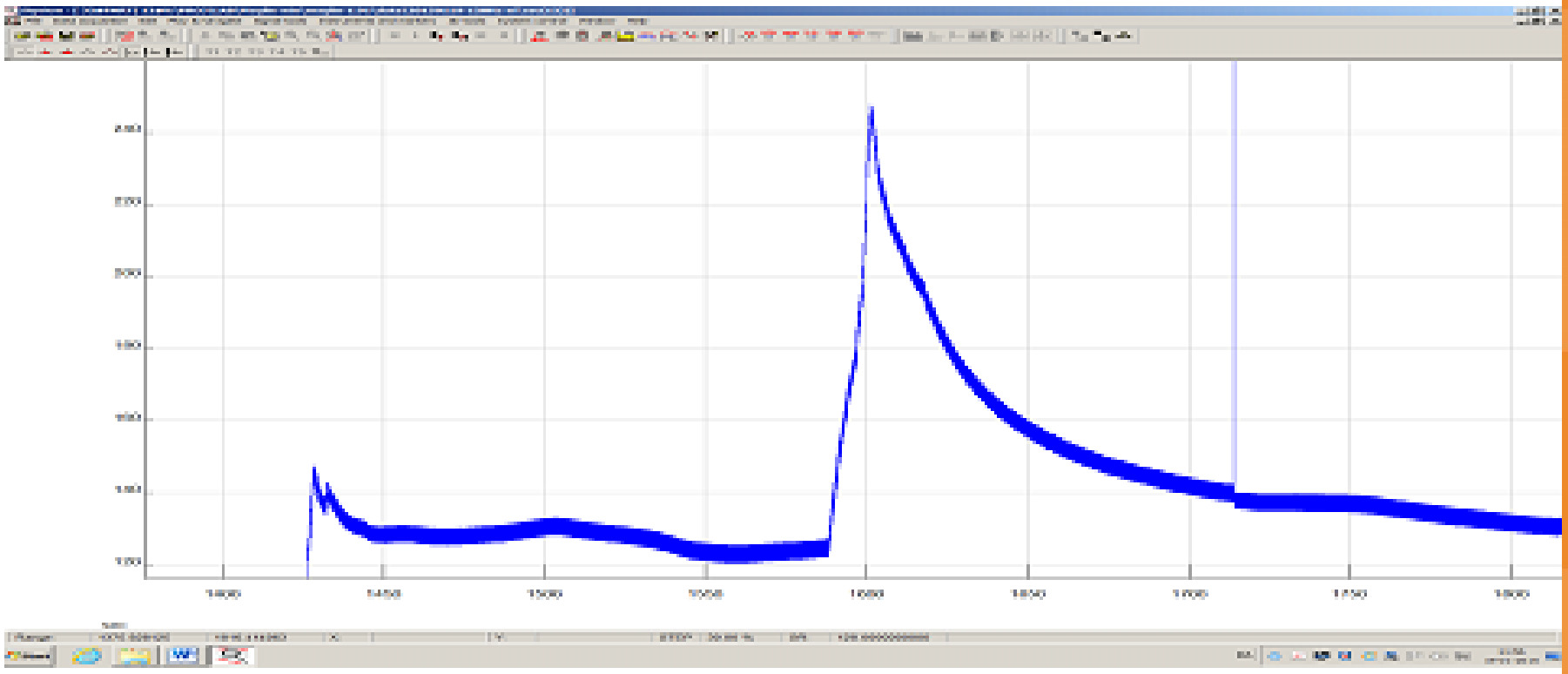
19. jan 2015.

Test B: Fluid: CaCl Time: 11.44 Sweep: 0.1-20 Hz in 100 s

Peak starts at 12 Hz and the top is at 15 Hz,

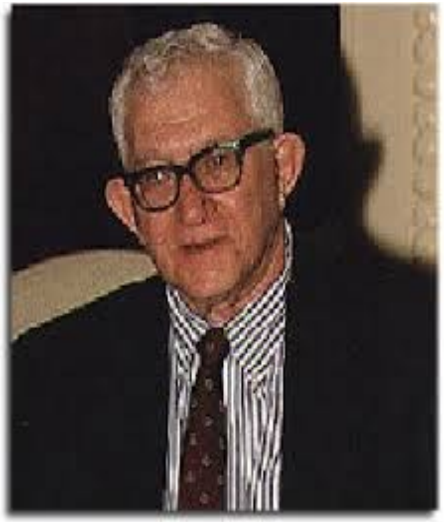
Electrometer: U peak at 15 Hz

Cell has been cleaned and fluid has been made 10-20 minutes before.



The *Liboff-Zhadin Effect and the so called Water EZ*

Abraham R Liboff



Martin Fleischmann

The Liboff Effect and Nze are the former prooves of the existence of pure and mixed CDs in water. Indeed

i. the β-dumping-shape of the peak shows that it is a resonant peak ;

ii. the observed peak of current overcomes the kT threshold without external source of energy (Del Giudice E & Giuliani L 2010) [14] (Del Giudice E & al., 2002) [10]; energy beeing provided by CDs [10, App. A];

iii. only molecules coming from CDs near the electrodes concur forming the peak of ion current (2006) [15]. This paper shows only CDs near surfaces are stable: that's why someone later discovered the so called EZ water (better as later, Inclusion Zone would be proper);

iv. previously CDs capture ions or zwitterions from bulk water the same then forming the ion currents detected in LZE. That's prooving the existence of mixed CDs and induced ionization by Non Ionizing Radiation in water;

v. moreover zwitterions, as glutamic acid in acid aqueous solutions (PH=2.9), are *ionized* by a very weak AC MF (20-80 nT), as it was straightly detected by means of FTIR-ATR by De Ninno A & A. Congiu (2010) [6a]

NZe implies MWCDs and ionization in water

Mikhail N Zhadin

Vadim V Novikov

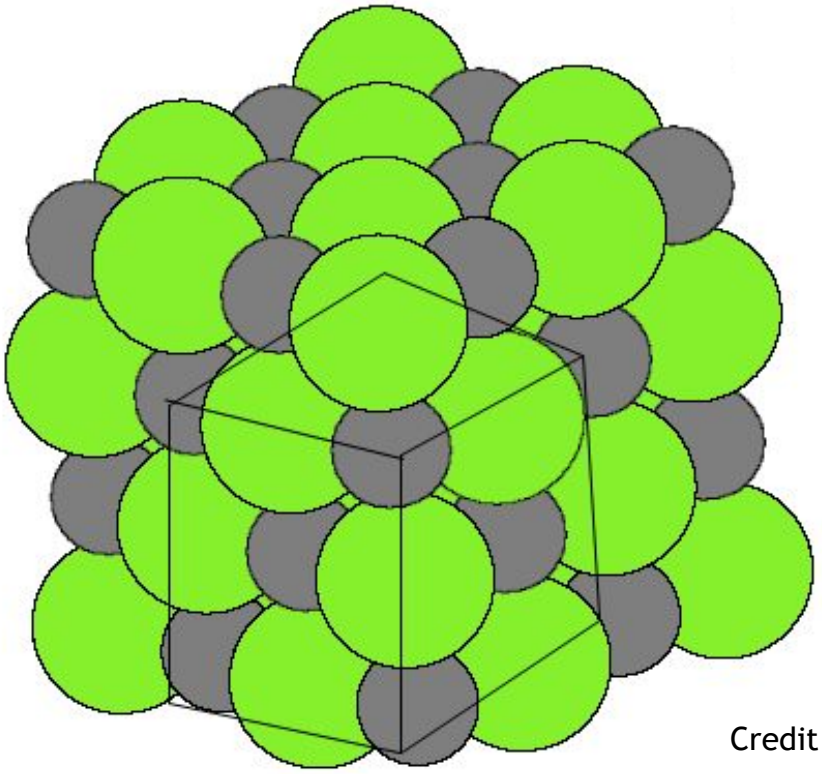
Specifically, the NZe early provided the proof of existence of Mixed Water CDs, made by H_2O molecules and ions coming from one or more chemical species, solved in aqueous solution (Zhadin M N & L Giuliani 2006) [16].

Summarizing:

- the Liboff effect shows that ions are forming a current, under a couple of DC-AC magnetic fields, tuned according to Ion Cyclotron Resonance, but the NZe shows that also zwiterions are able to form a current and it implies their own previous ionization
- Ionization occurs on the boundary of CDs, according to the argument early provided in the quoted [16] and to the mechanism described in the quoted [14] and in the continuation.

NZe – 1^Step: *attraction*.

A MIXED COHERENT DOMAIN



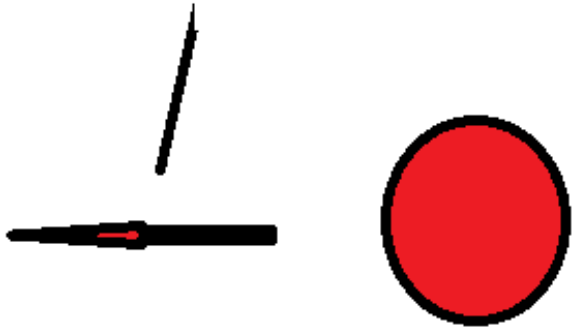
The Hydrogen bond suggests a tetrahedral geometry.
In grey water molecules, in green other molecules already captured in the boudary of the Water Coherent Domain

$$F = - q\nabla|A|^2/(2m) = qV$$

F ponderomotive force, m mass,

A and V, respectively, magnetic

vector- and electric scalar- potential

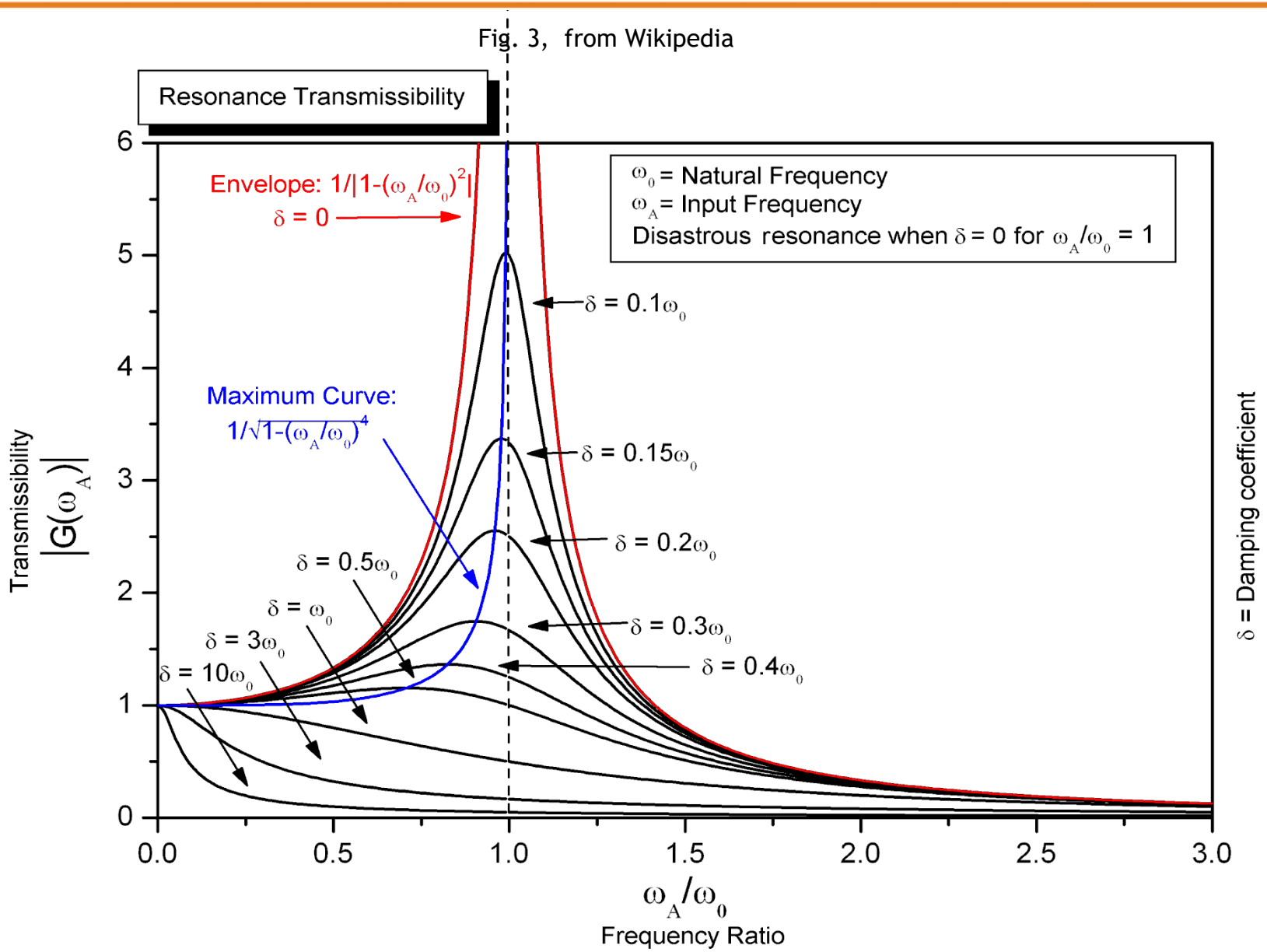


An artistic image
Credit to Grafimax by M. Paolini

A molecule (an electric dipole or zwitterion), is captured by CD on the left, provided its oscillation frequency, in IR band, is close to the one of water.

A *Coherent Domain* has an electromagnetic field B trapped inside, which is the cause of the formation of the CD itself. **B = ∇ x A.** Outside there is not coherence. Thus there is neither B nor A. As a consequence, there is a strong gradient of |A| on the CD-boundary.

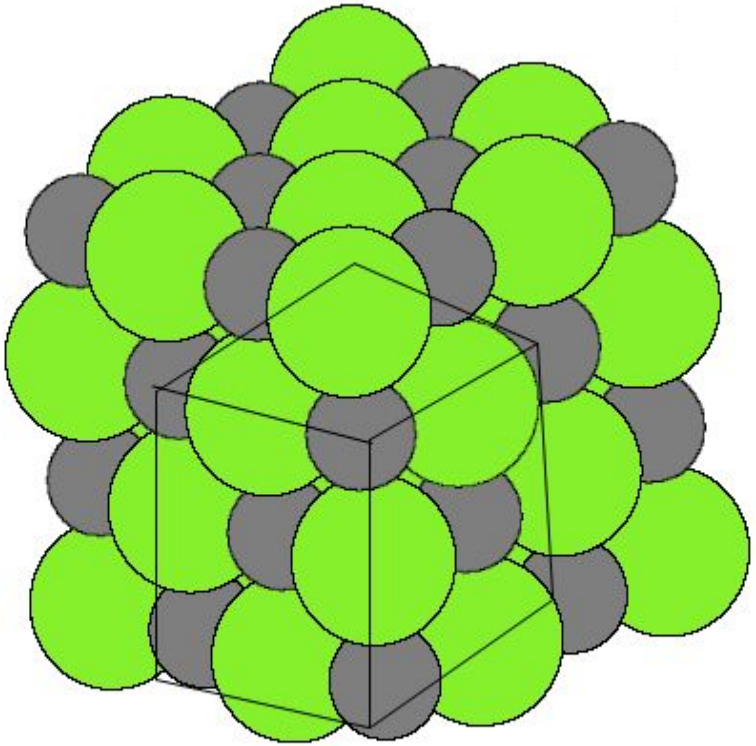
Resonance in classical physics



NZe – 2^ Step:
mixing by resonance.

The attraction is due to a well known strenght in classical electromagnetics CDs are structures with minimum energy and entropy since their molecules are tuned in phase, they cannot be penetrated by molecules not in phase.

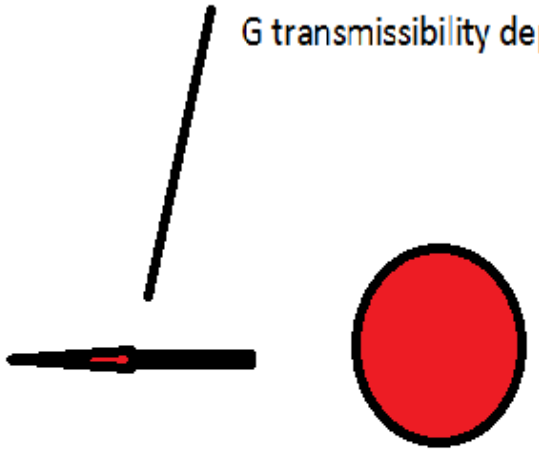
A MIXED COHERENT DOMAIN



The Hydrogen bond suggests a tetrahedral geometry[2b]- In grey water molecules, in green other molecules already captured in the boudary of the Water Coherent Domain

$$G(\nu) = 1/[1-(\nu_{mol} - \nu_{water})^2]$$

G transmissibility depending on frequency ν



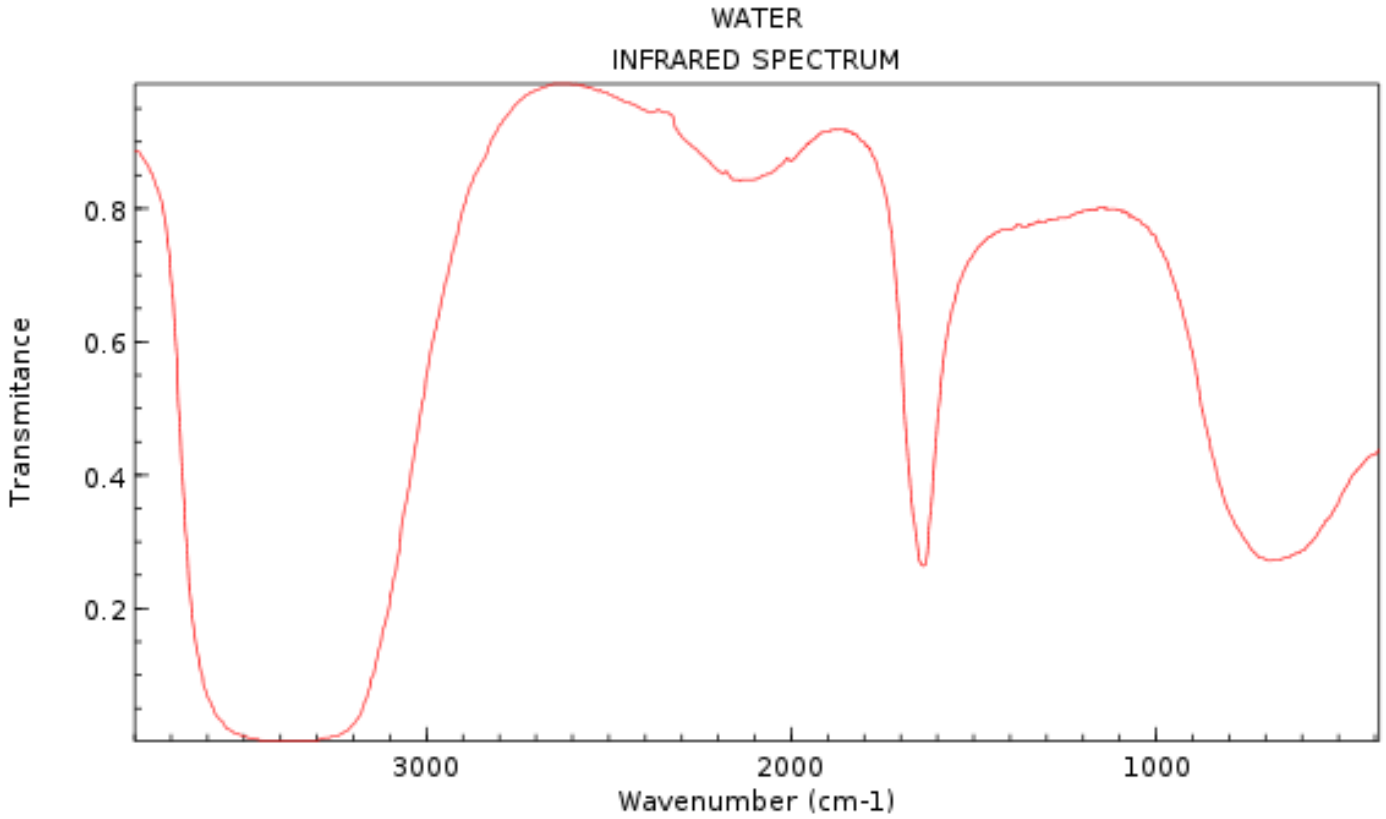
A molecule (an electric dipole or zwitterion), is captured by CD on the left, provided its oscillation frequency, in IR band, is close to the one of water.

Water *IR* spectrum

NZe can be extended to other chemical species, not to all of them.

Constraints are imposed by *resonance*.

Molecules can be captured by water CDs, forming MWCDs, only if they have vibration modes in the proximity of water ones, as in the following Fig.4. IN the case, surficial water is inclusive, for other chemical species becomes EZ water!



NIST Chemistry WebBook (https://webbook.nist.gov/chemistry)

Water and Heavy Water *IR* Spectrum

Only water has two peaks so large and so deep to include so much!

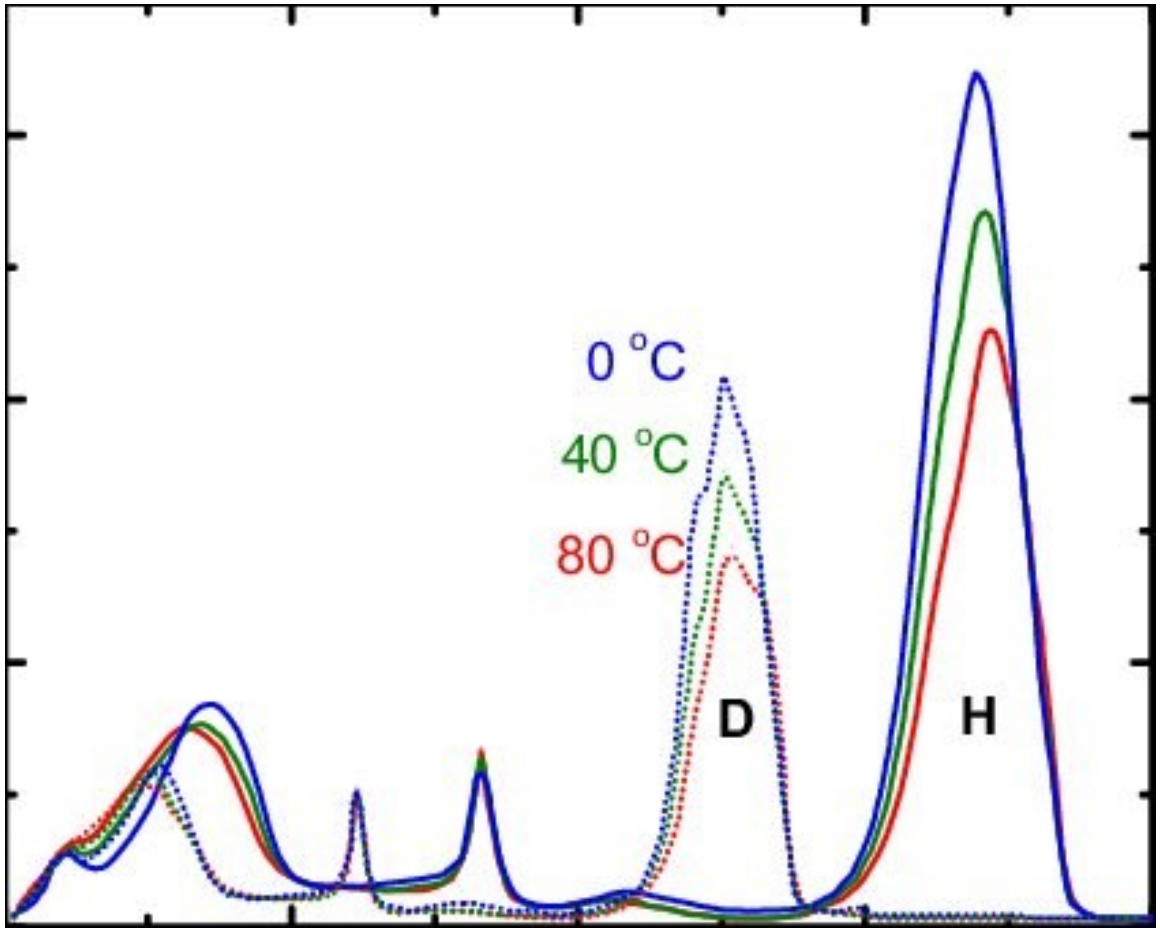


Fig. 4 bis. IR spectra of 1 m-thick ordinary water (H) and heavy water (D) reveal that D isotope attenuates the intensity and softens all phonons of the H_2O, although the shape of spectra is the same at all temperatures (Chang Qing Sun & Yi Sun, 2016). From [16,Fig.37]

Water and Heavy Water
IR Spectrum

Only water has two peaks so wide and so deep to include so much!
Not so wide to include, for istance, titanium dioxide.

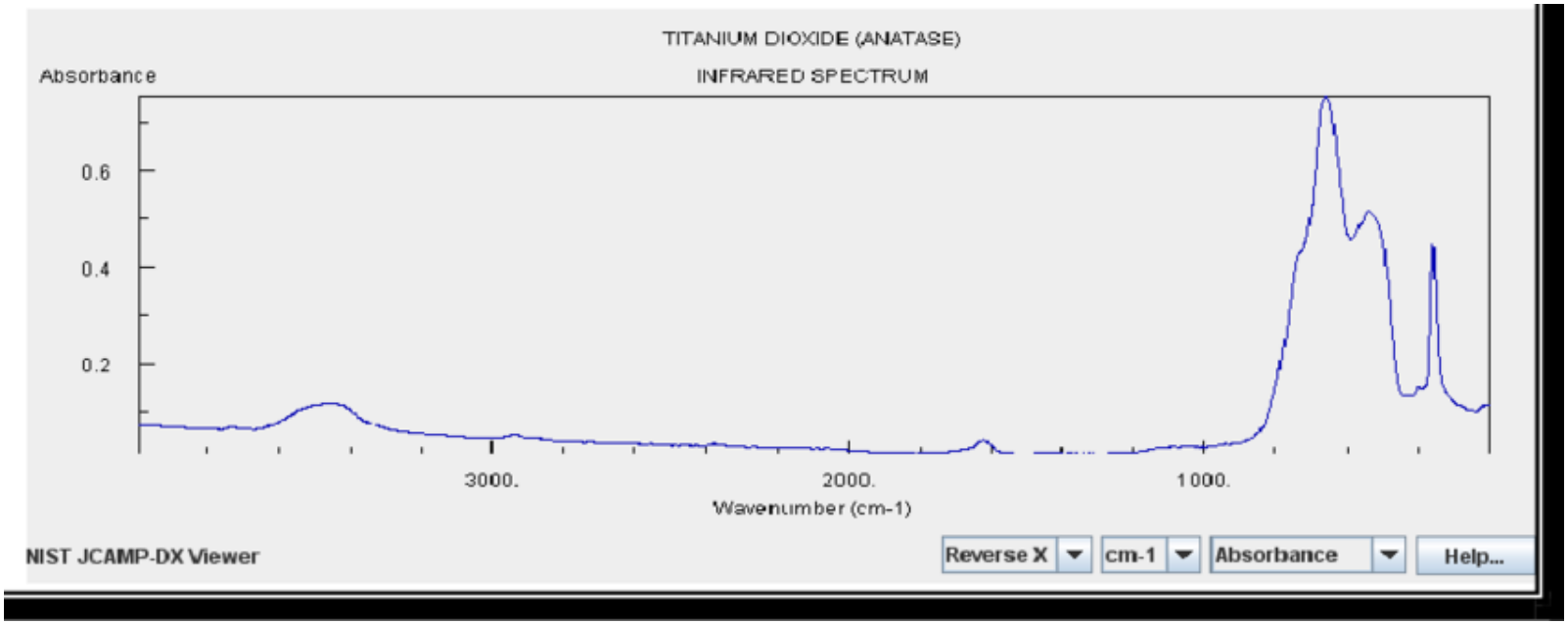


Fig. 4 ter. IR spectrum of titanium dioxide. Absorbance in ordinates. TiO_2 has neither a relevant peak close to the O-H water phonons peak, about 3000 cm^{-1} , nor a peak about 1650 cm^{-1} like the electron oscillator of water. For TiO2 surficial water is EZ water!

NZe – 2^ Step: *mixing by resonance*

WHAT HAPPENS WHEN A COHERENT DOMAIN CAPTURES AN EXTERNAL MOLECULE? *ORDER INCREASING*.

Resonance plays its role, as in the movie «32 metronome synchronization» linked at https://youtu.be/5v5eBf2KwF8?t=21

Before the zwitterion capture by CD:

$$0<(\nu_{mol}- \nu_{water})^2 << 1$$

i.e.

$$\nu_{mol}\cong\nu_{water}$$

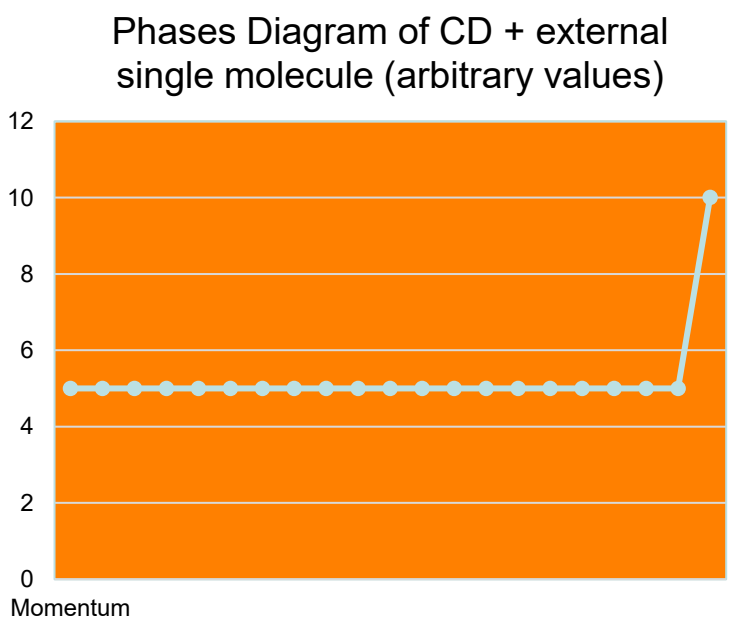
After the capture

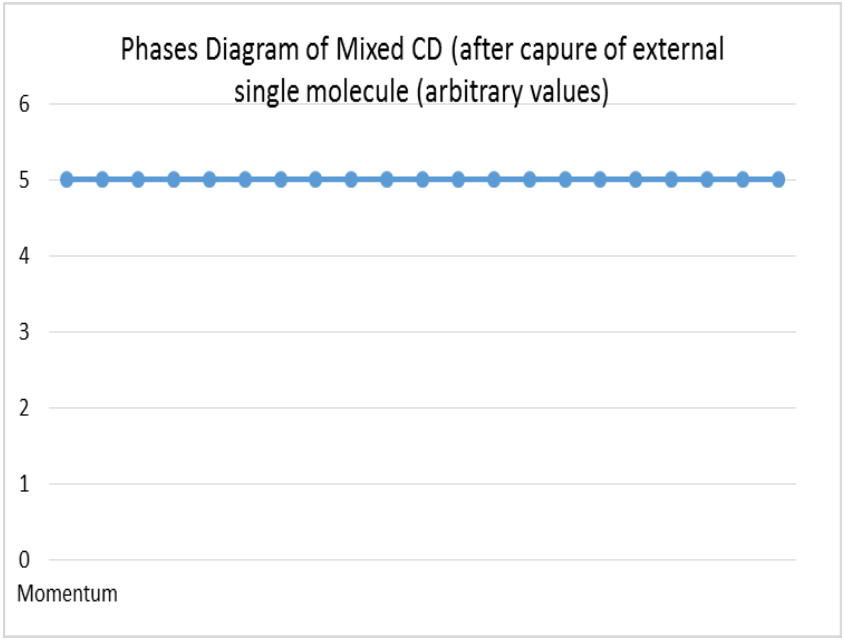
$$\nu_{mol}\equiv\nu_{water}$$

In a MWCD all molecules oscillate with the same frequency. If the frequency is the one related to the oscillation of nucleons captured molecules simulate water molecules and share their energy.

NZe – 2^ Step: mixing by resonance.

WHAT HAPPENS WHEN A COHERENT DOMAIN CAPTURES AN EXTERNAL MOLECULE? *ORDER INCREASING (Fig. 6-7)*





A more ordered stage is reached: all the molecules, after the capture, have the same momentum. The system losses one degree of freedom, i.e. in principle, it reduces of ∞^1 the number of possible vectorial stages of the system. If we approximate ∞^1 with N>>0, where N is the maximum of stages with different momentum of the external molecule with non negligible probability. If Γ, Γ^* are the set of arrays of the molecules of the system before and after the capture, we have $\Gamma^* = \Gamma/N!$.

NZe – 2^ Step: mixing by resonance

TWO SIMPLE MODELS TO GET A QUANTITATIVE ESTIMATION OF BEHAVIOUR OF ENTROPY IN A NZe.

In the case of maximum density of water (~4 °C, 10^5 Pa), we can assume that the number of placements with non negligible probability is roughly equal to the number of molecules in incoherent water, N_{bulk}, due to the maximum density of water; and such number be roughly the same of water molecules in the coherent fraction, N_{water} [Fig. 1].
Let us consider the case when the moments of molecules in the bulk does not change, but the one of molecules captured by CDs. Thus, computing the difference of entropy before and after the capture, they are not important the values of moments, but only their number, after a suitable discretization. In the case, in order to compute the number of configurations of the crystal (CD) following a blending, we could apply the well known formula for blending atoms of two species B, C to a crystal of atoms of species A:

$\Gamma = (N_A+N_B+N_C)!/(N_A!N_B!\ N_C^!)$. In our further hypothesis $N_{water} \cong N_{bulk}$ [6]

where $N_{bulk} = \max \{N_{bulk,placements}, N_{bulk,moments}\}$, $N = \max \{N_{water}, N_{bulk}\}$ and $N >> 1$

NZe – 2^ Step: mixing by resonance

WHAT HAPPENS IN A NZe? ENTROPY INITIALLY DECREASES AND THEN INCREASES. IT IS AT ZERO-SUM.

We can further approximate, when N is large enough,

$\Gamma=(N_{water} + N_{bulk})!/ (N_{water} ! N_{bulk,placements}! N_{bulk,kmoments} !)$. i.e. $\Gamma \cong (3N)!/N!^3$

$$\Gamma^* \cong (3N+1)!/((N-1)!(N+1)!^2)=(3N+1)N/(N+1)^2\Gamma \cong 3\,\Gamma$$

$$\Gamma^{**} \cong (3N-1)!/((N+1)!(N-1)!^{2)} = (3N)!/[3N(N+1)N(N-1)!^3 \cong \Gamma/3$$

From here on '≅' means "definitely equal"

$S \cong k \ln(3N)!-3k \ln N!$ **$S^* \gtrsim k \ln 3 + S$** **$S^{**} \lesssim S - k \ln 3$**

$S^*-S \gtrsim k \ln 3 > 0$ **$S^{**}-S \lesssim - k \ln 3 < 0$** **$S^*-S^{**} \cong 2 k \ln 3$**

$S^*+S^{**}- 2S \cong 0$

NZe – 2^ Step: mixing by resonance

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WHAT HAPPENS IN A NZe? ENTROPY INITIALLY DECREASES AND THEN INCREASES. IT IS AT ZERO-SU

In the case of maximum density of water (~4 °C, 10^5 Pa), in the same upper hypotheses, instead of combinations we can consider a simplest model, based on the set of permutations of molecules along the three axes of vectorial phases: one for the placements of molecules belonging to Coherent Domains and two axes for the molecules of bulk water.

Thus we can further approximate, when N is large enough:

$$N_{water} \sim N_{bulk} \cong N >> 1 \qquad \Gamma \cong N_{water}!\, N_{bulk}!^2 \cong N!^3 \qquad S = 3k \ln N!$$

$$\Gamma^* = (N-1)!(N+1)!^2 = (N)!^3 N(1+1/N)^2 \quad \& \quad S^* = k\,[3 \ln N! + \ln N + 2 \ln (1+1/N)]$$

$$\Gamma^{**} = (N+1)!(N-1)!^2 = 1/N(1+1/N)N!^3 \quad \& \quad S^{**} = k[3 \ln N! - \ln N + \ln (1+1/N)$$

$$S^*-S = k\,[\ln N + 2 \ln (1+1/N)] > 0 \quad \& \quad S^*-S >\cong k \ln N \quad \text{as } N >> 1$$

$$S^{**}-S = k\,[\ln (1+1/N) - \ln N] < 0 \quad \& \quad S^{**}-S = -k \ln N < 0, \text{ as } N >> 1$$

$$S^*-S^{**} = 2k \ln N + \ln (1+1/N) > 0 \quad \& \quad S^*-S^{**} >\cong 2k \ln N \quad \text{as } N >> 1$$

$S^*+S^{**}-2S \cong 3k \ln (1+1/N) \geq 0$ & $S^*+S^{**}-2S \cong 0$ as $N >> 1$

NZe – 2^ Step: mixing by resonance.

WHAT HAPPENS WHEN A COHERENT DOMAIN CAPTURES AN EXTERNAL MOLECULE? ENTROPY DECREASES

$\Delta S^* = S^* - S = k \ln N > 0$ & $\Delta S^{**} = S^{**} - S \geq -k \ln N < 0$, as $N >> 1$

Solvating soluble molecules (e.g. an ion escaping a MWCD) **in the uncoherent fraction** of an aqueous solution,
entropy increases,
but when a molecule is captured by a CD
in the coherent fraction, entropy decreases.

At the lab pressure and temperature and in an electrolytic cell, where the volume of the solution doesn't change, E_G, the free energy, is related to entropy variation:

$$\Delta E_G = E - T\,\Delta S$$

then

$$\Delta E_G^* < 0$$

while

$$\Delta E_G^{**} > 0$$

(* and ** as in the previous notation).

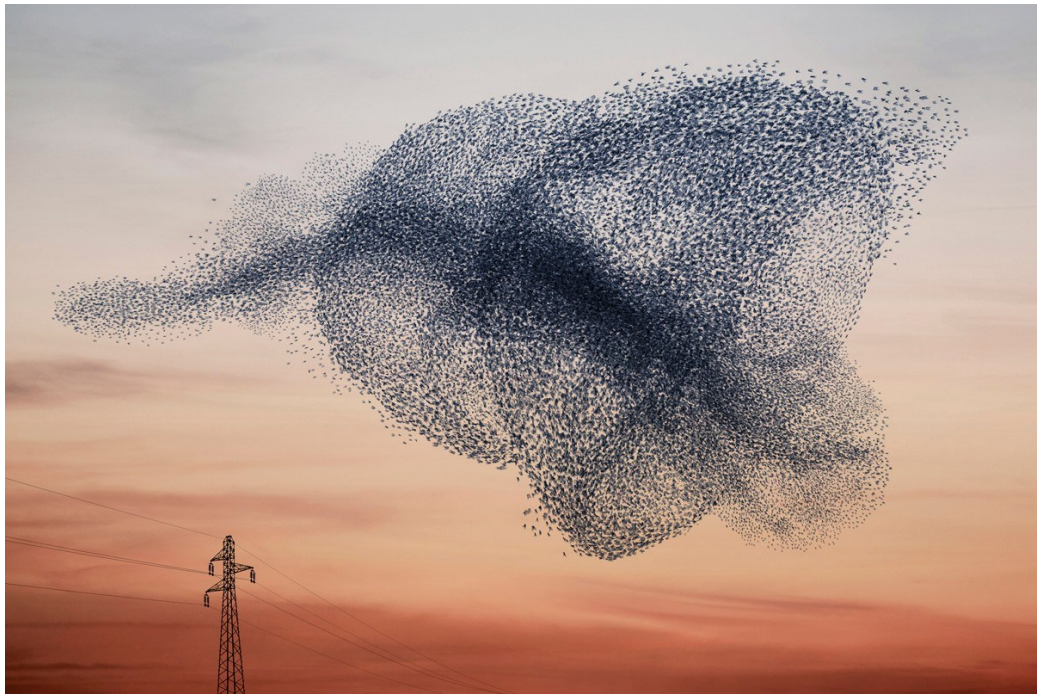
NZe – 3^ Step: *storing energy.*

We have to provide energy when we solve a soluble molecule in aqueous solution (for instance, turning the teaspoon into the coffee cup), but in the coherent water,

a fraction of the provided energy is stored in a Mixed CD.

Somewhere.

As in a flock of birds, there are many way to store energy in the angular momentum in a CD, the preferred way being the one that increases order and decreases entropy.



NZe – 3^ Step: *storing energy*

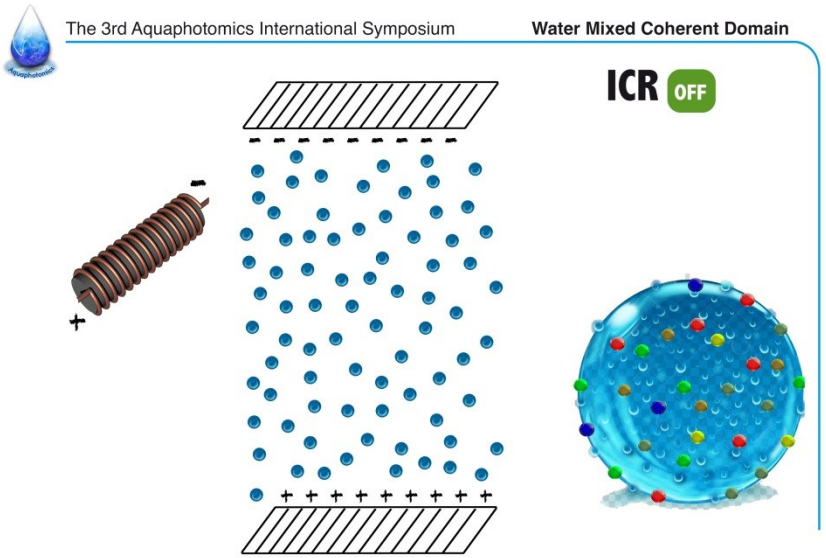
WHERE?

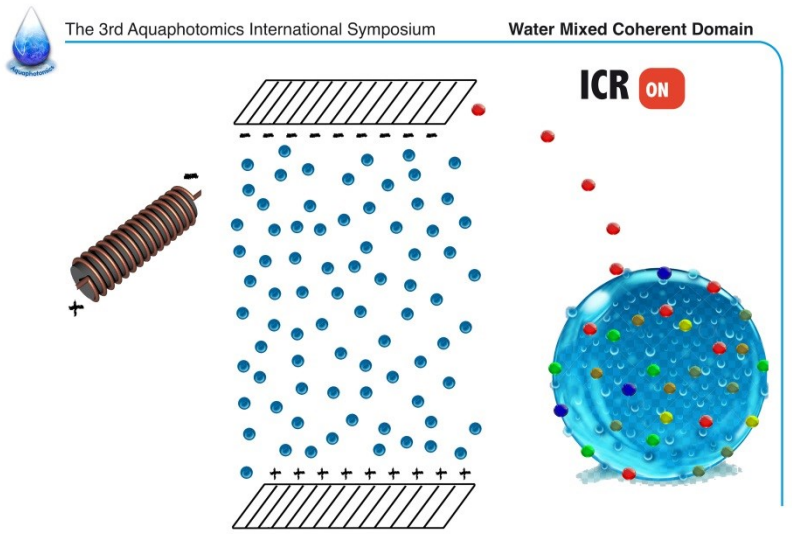
Electrons in CD are ***almost free***, since the energy gap $h\nu$ –h being the Planck constant ν the frequency- between the ground and the first excited state of a water molecule is:

$$h\nu = 12{,}06 \text{ eV} \cong 12{,}60 \text{ eV} = h\nu_{escape}$$

Since in the CD there are more than 5 millions of molecules and 13% of all water molecules are actually in the first excited state [3], the almost free electrons are so many to create vortices on the surface of the CD; and energy is stored, for instance, in the angular momentum of these vortices, ready to be released and shared, in the selected channel of electromagnetic interaction, when a molecule escapes the CD, under the *Liboff-Zhadin* effect.

NZe – 4^ Step: releasing Energy and information





Credit to Grafimax by M. Paolini

It recalls a train running with the door open. The solute molecule is like a voyager who can get on or off the train, under the influence of the ponderomotive attraction or under the LZ, respectively. He get off with the kinetic energy of the train, as well.

NZe – 4^ Stage: releasing Energy and information

Ion motion is almost straight, along the ion cyclotron orbit in highly coherent ambient as we can suppose to be the cytoplasm. The electric field does the rest. But ion initially escapes along its cyclotron orbit, with radius r= vm/qB=2E/m.

Finally, ion escapes adding to E – energy provided by the applied alternate magnetic field- the vibrational one of the water CD too!

It recalls a train running with the door open. The solute molecule is like a voyager who can get on or off the train, under the influence of the ponderomotive attraction or under the LZ, respectively. He get off with the energy of train

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Water CD is a *negentropic* engine

able

- to capture energy and matter from everywhere in every way and
- to store them in electron vortices,
- to release the energy stored to escaping ions in the channel of electromagnetic interactions, under LZ,
- to release information in the form of charged mass with cyclotron motion, thus providing information about itself.

It recalls a train running with the door open. The solute molecule is like a voyager who can get on or off the train, under the influence of the ponderomotive attraction or under the LZ, respectively. He get off providing information about its own identity, as he fell with a banner

The *extended Liboff-Zhadin Effect (**eLZ**)*

Giuliani L *et al*. (2008) observed that the Liboff-Zhadin effect arises in a vessel without sunk electrodes, as well, under a suitable static electric field (~ 0,1 V) [18-19].

The upper observation seems to be crucial to explain ion currents in cytoplasm, which is surrounded by cell membrane, which can be approximated by a spherical condenser surface.

It is an extension of the Liboff-Zhadin effect outside of the electrochemistry that concerns biology, better, cytology.

Indeed LZe induces motion of calcium ions in cytoplasm even from cell organelles, shown in the short video by Grimaldi S and colleagues at CNR-Tor Vergata *Hypomagnetic Facility* [next page].

This fact allowed us to apply interaction between electromagnetic fields and water - based on LZe to several topics in Biology and Medicine, following the Liboff's patents and intuition [21-29] and to formulate hypotheses about the others' use of the LZ-effect [30-44].

The extended Liboff-Zhadin Effect (eLZ)

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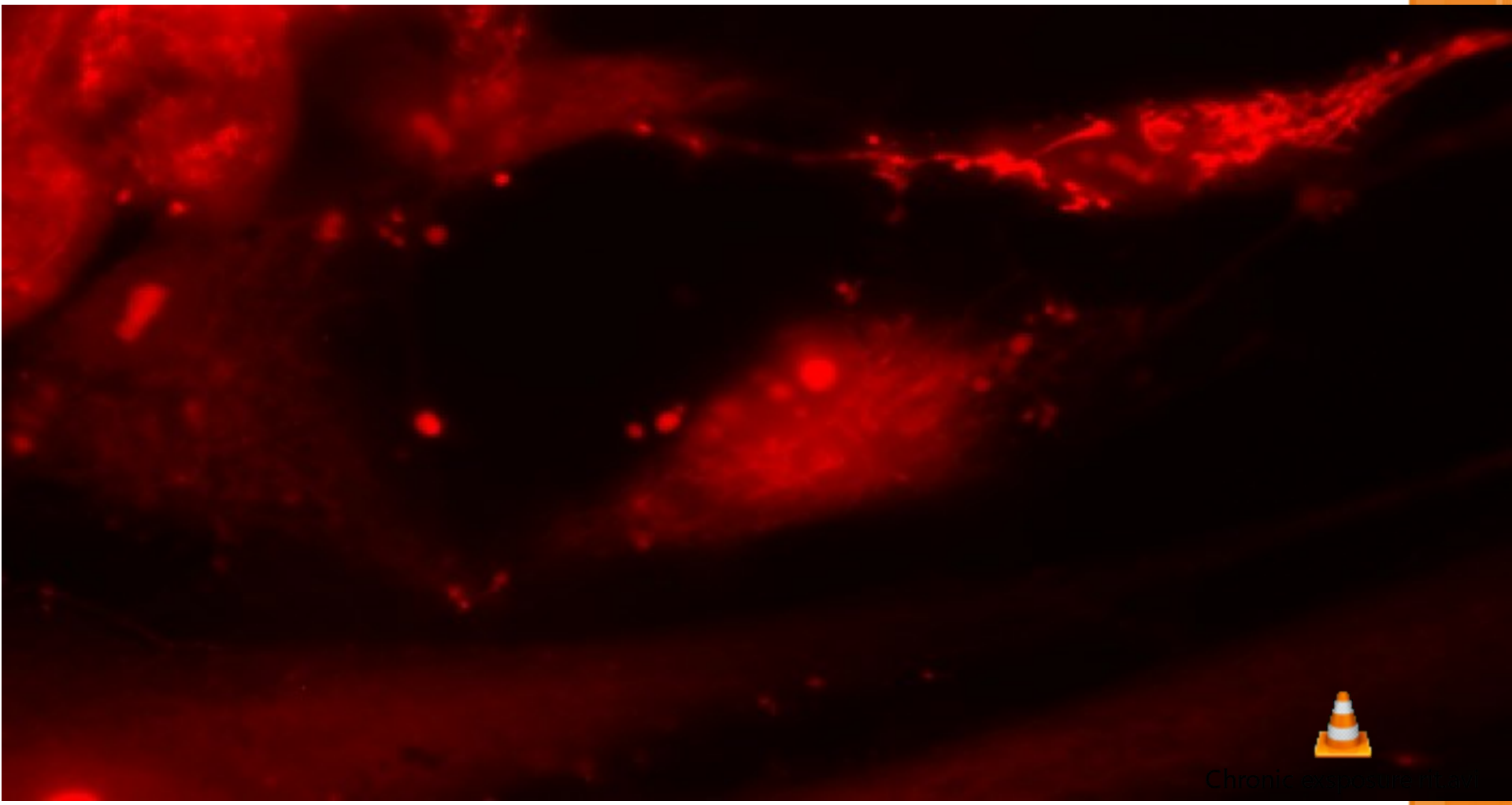

Calcium chromophores of a cell are marked with Rhode island and then observed by means of a microscope equipped with a coil generating DC and AC MFs. When the coil is switched on and MFs are tuned with the Ca^{++}-ICR, CA-ions escape from organelles and diffuse in cytoplasm.

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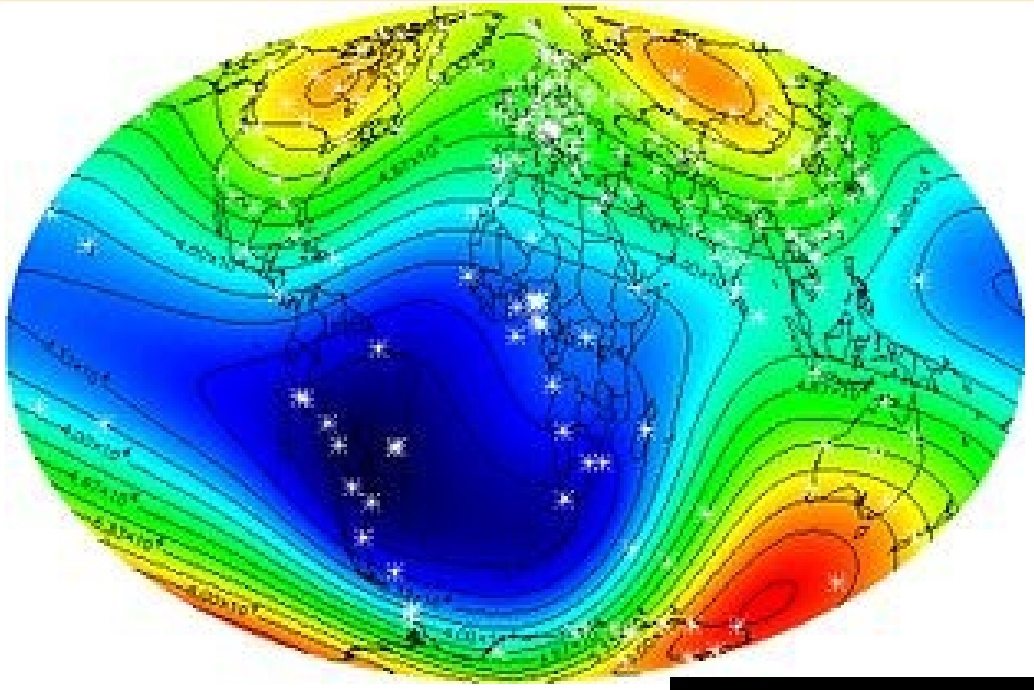
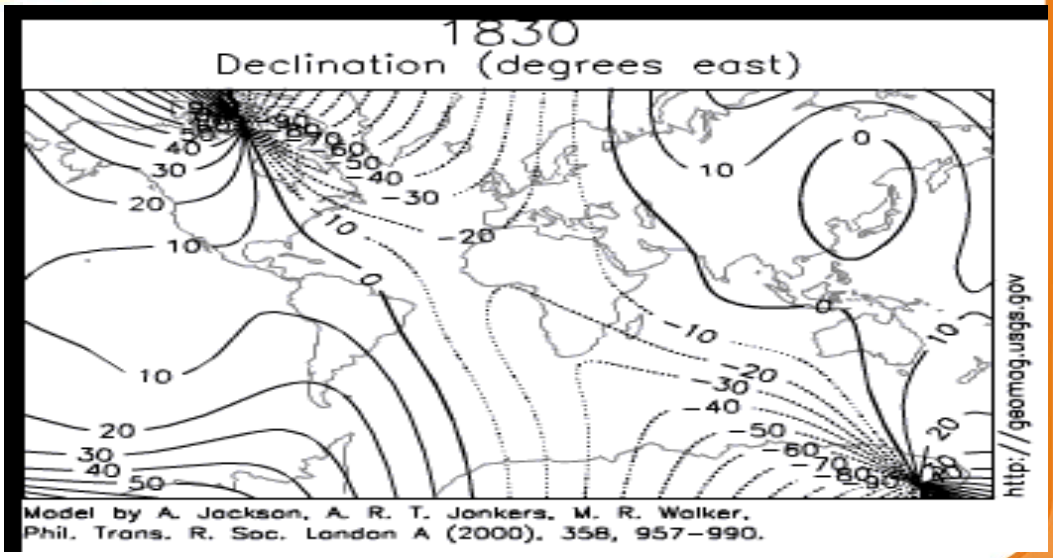
Many thanks to Lars Pedersen, Michael Bake, Nikolaj Blom for the brilliant Liboff-effect, detected at DTU, Kgs Lymby (Copenhagen) [look at previous p.11]



Geomagnetic intensiity distribution in 2000 (from IGRF)

THANK YOU SO MUCH!

The magnetic declination distribution is stongly depending on time (http://it.wikipedia.org/wiki/Campo_geomagnetico)



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