Electromagnetic resonance in biological systems: Myth or reality?

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Outline

- introduction
- investigation within mainstream domain
- investigation in alternative medicine
- tumor specific frequencies
- conclusions

Introduction

- What is resonance in biological system:
  larger effects are evoked due to feeble stimulus characterized by specific parameters (frequency, intensity, concentration), while they are absent for slightly shifted values of these parameters
- beneficial and adverse health effects
- rich potential for diagnostics and therapy
- claims on resonance in evidence based and alternative medicine: is there any reasonable border?

Interaction mechanisms

- **Electrodynamic interactions** (molecules and higher compounds)
  - magnetic induction of electric fields and currents
  - Lorentz force (heart)
  - Magnetohydrodynamic forces (blood flow)

- **Magnetomechanical interactions** (molecules and higher compounds)
  - torque on magnetic dipole moment
  - magnetophoresis (force on magnetic dipole moment)
  - anisotropic diamagnetism

- **Radical recombination rates** (subatomic interactions)

- **Biogenic iron**
  - singel-domain magnetic crystals
  - superparamagnetic magnetite

Interaction mechanism - models

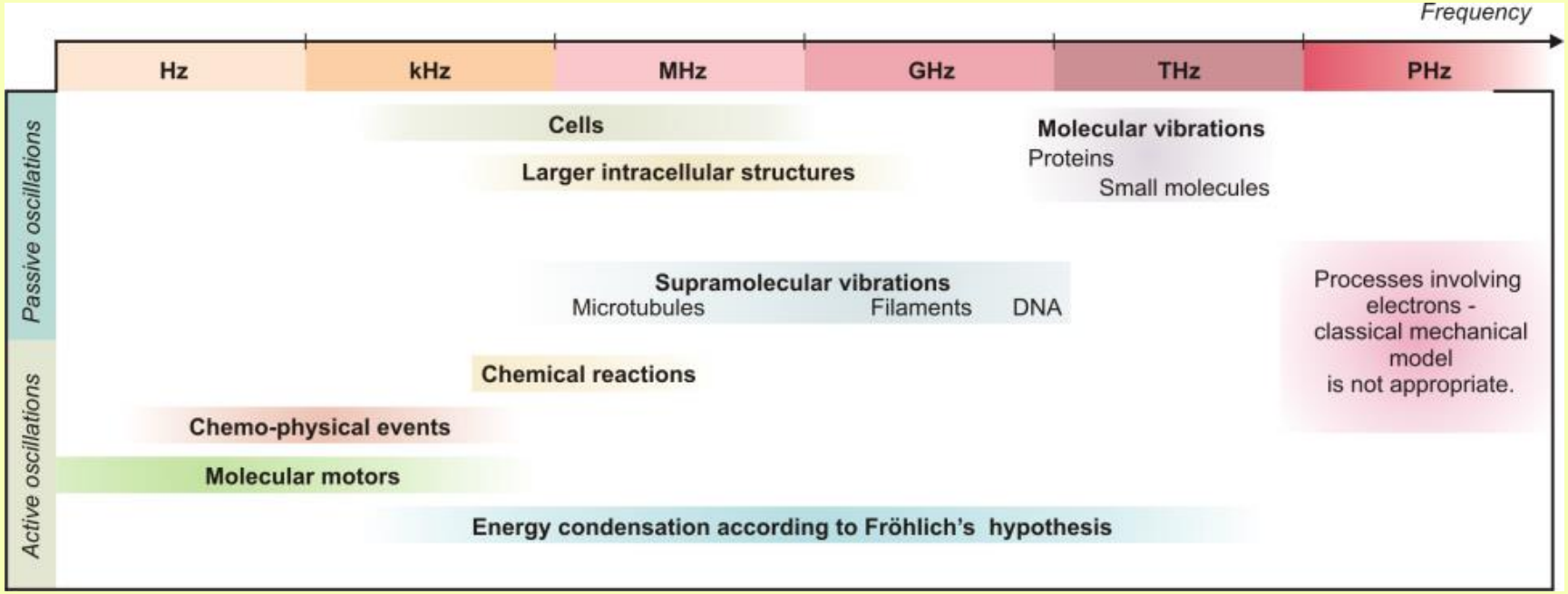
MODEL	Year	Author(s)	Range
Polarization force	1992	K. McLeod	
Oscillatory activation barrier	1992	V. Markin, T. Tsong	kHz
Ion activation	1996	M. Blank, L. Soo	MHz
Free radicals	1996	J. Walleczek, C. Timmel	DC-Hz
Electroconformational coupling	1998	R. Astumian, T. Tsong	MHz - GHz
Forced vibrations of free ions	2002	D.J. Panagopoulos	kHz
Ion cyclotron resonance	1987	A. Liboff, B. McLeod	Hz
Larmor precession	1993	D. Edmonds	Hz-kHz
Ion parametric resonance	1989, 2001	V.V. Lednev, J. Blanchard, C. Blackman	Hz DC-Hz-kHz
Coherent oscillations	1943, 1996	H. Frohlich, J. Pokorný	kHz-GHz

Nature of the oscillatory processes

- mechanical: > Hz (human body), > kHz (cells)
- electronic: few Hz – PHz (optical band)
- electromagnetic: > MHz (human), >THz (cells)
- Sustainable resonances: quality factor $Q = f / \Delta f >> 1$

Mechanical/vibrational resonances

- mechanical: > Hz (human body), > kHz (cells)
- viscous damping limits resonance <THz



O. Kučera and D. Havelka: Mechano-electrical vibrations of microtubules - link to subcellular morphology. *BioSystems, 109(3):* 2012.

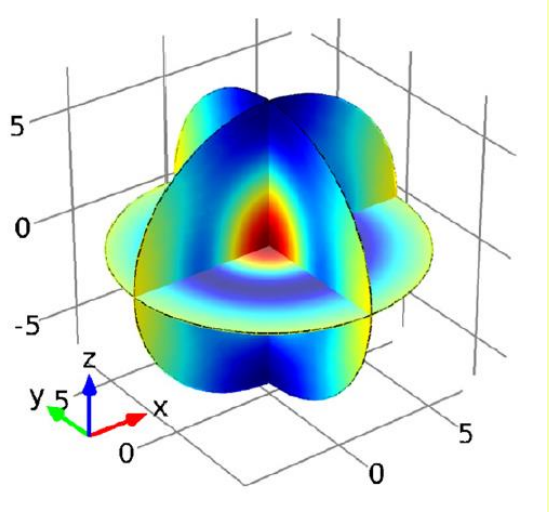
Electronic resonances

- few Hz – PHz (optical band)
- requires sufficient mobility of electronic, i.e. high “electric conductivity” and formation of resonant (capacitance/inductance) circuits
- inductance elements are usually not found in biosystems
- biomaterials/biomolecules typically do not display high electrical conductivity -> no rigorously confirmed electronic resonances

Electromagnetic (cavity) oscillations

- > MHz (human), >THz (cells)
- biological dielectrics are lossy and scattering – prevents strong resonances

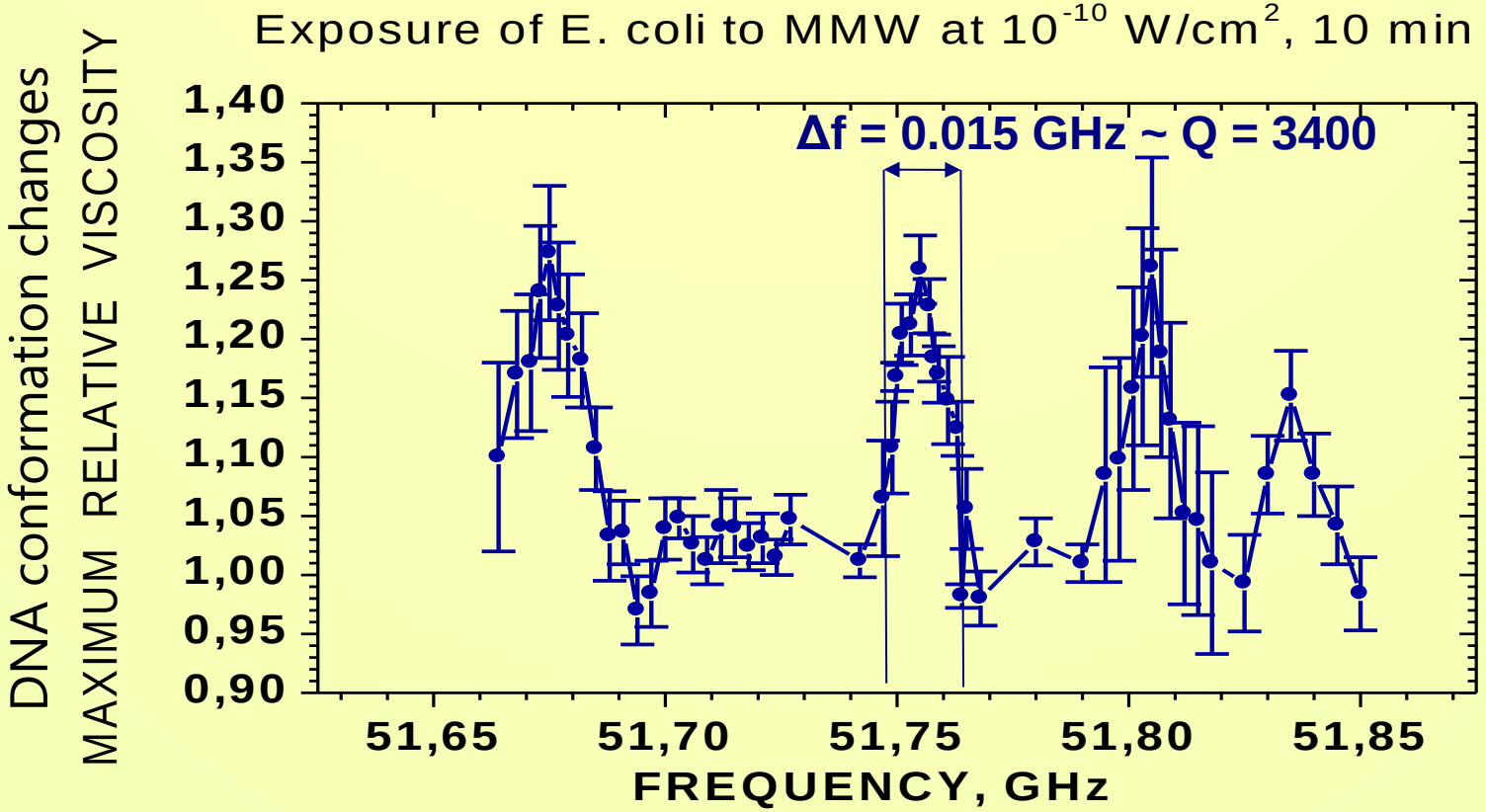
Dominant eigenmode of spherical cell as dielectric resonator
r = 7μm, f = 24 THz, Q ~ 1



M. Cifra: Electrodynamic eigenmodes in cellular morphology. *BioSystems, 109(3):* 2012

Example of bioresonance findings in scientific literature

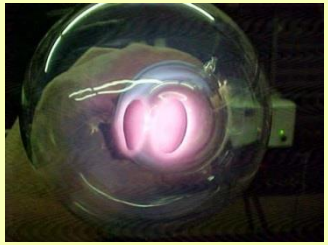
Frequencies which give different biological effects are very close to each other.



Belyaev *et al. Bioelectro magnetics, 17: 1996.*

Controversial history of electromagnetic phenomena in biology and medicine

- Dr. Royal Raymond Rife (USA - physics, medicine)
  - **Universal microscope** (Report of Smithsonian Inst. Reprint from J. Franklin Institute, vo.237, N2, 1944)
  - **Plasma ray tube with audio oscillator**, 140 kHz – 20 MHz clinical instrument, search for frequencies destroying patogenes



- Prof. Georges Lakhovsky (France, electronics, medicine)
  - **Multiple Wave Oscillator** 750 kHz – 3 GHz, succesfull experiments with artificially induced tumors in plants, reports on healing in NYC hospital
  - Book **"The Secret of Life"** (1939) – postulates on electrical attributes of living cells; all living cells generate EM oscillations, introduced an energetic view of diseases

Controversial history of electromagnetic phenomena in biology and medicine

- Prof. Antoine Prioré (France - physics, medicine)
  - **magnetron oscillator** microwave generator 9.4 GHz with μs pulses at 1 kHz rate
  - **plasma ray tube with audio oscillator,** short Radio Waves - 17.6 and 15.8 MHz
  - **research report for the Bordeaux University**, 1974: "*Healing of the acute and chronic experimental Trypanosomiasis*", a hypothesis on stimulation of defense mechanism

- Prof. Bjorn Nordenstrom (Sweden, diagnostic radiology)
  - **biologically closed electric circuits** Karolinska Institue and Hospital, postulates on electrical activity in tumors, questions on its oscillations

Investigation into bioresonance

- commercial branch within Alternative and complementary medicine
- extrapolated simplifications suggested that every alive and even lifeless form or material has its own subtle energy field with characteristic vibrations that can be measured and afterwards strengthen or eliminated
- from this concept a claim of a cure for virtually every illness and condition has arisen
- members of official mainstream science in general deny these issues without deeper explanation. However, in privacy more and more educated people are in favor of bioresonance

Bioresonance: phenomenon in alternative medicine

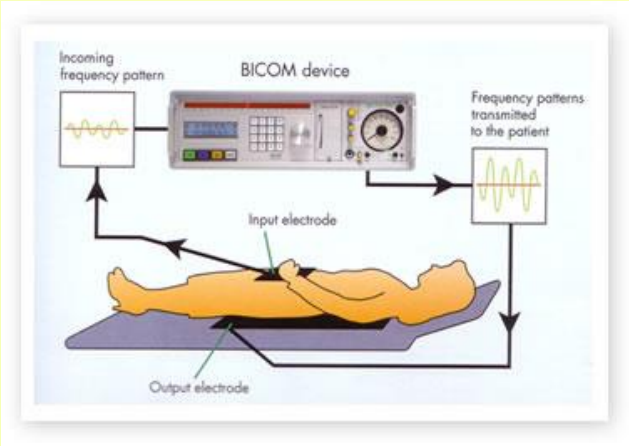
- examined various types and most common devices on the market:
  Bicom, Super Ravo Zapper, F-scan, Metatron

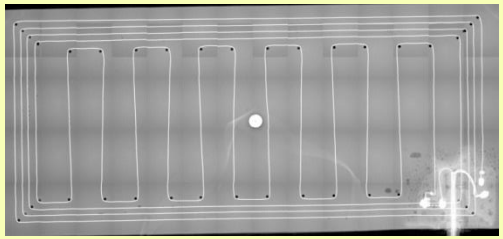
- “each cell, patogene, or even nonliving matter has it’s own resonant frequency”

- frequency tables (Rife, Clark): 10 000s items, Hz – 100 kHz, with 0.01-1 Hz precision

Bicom - claims

- every substance displays specific frequency patterns (10 Hz – 150 kHz)
- during therapy specific frequency patterns from a patient or from substances that harm or stress the organism are picked up. Inside the device these frequency patterns are modulated and applied back to the patient.
- BICOM bioresonance method works with a patient's specific endogenous frequency patterns and with the specific frequency patterns of the substances that are stressing the patient.
- measured spectrum is divided into physiological and pathological part
- pathological part is inverted and send back – "eliminates" ill vibrations
- uses a combination of principles from traditional chinese medicine, homeopathy and quantum physics "to test and treat" stresses on your body

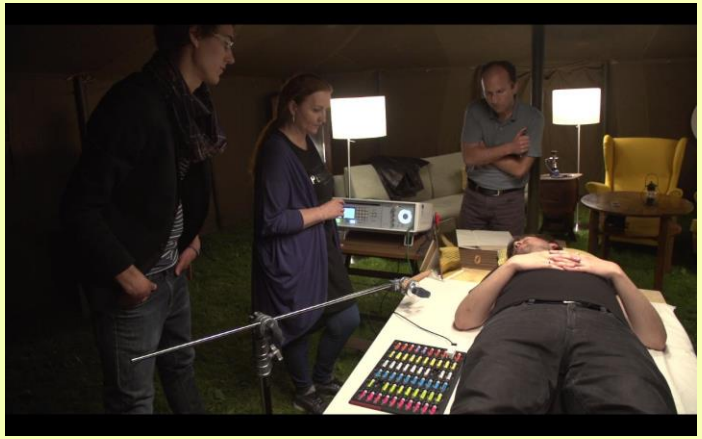




CT of the applicator

Bicom - findings

- signal from patient body measured by electrode connecting only by 1 wire
- signal sent to healing applicator is able to induce magnetic field only hidden in geomagnetic background; it is supposed to serve only as a carrier for therapeutic information
- company chiefs: “operation principle is very secret thing”
- pretending objectivity: the mostly used diagnostic tool: rod “biotensor”, functioning even when unplugged from the expensive device
- instructions for use: focus on momentarily complaints of the patient and his or her history of health problems = bias
- typical patient: psychosomatic problems + parallel use of therapies (diet, etc.)
- origin in Germany, 70’s, Scientology club



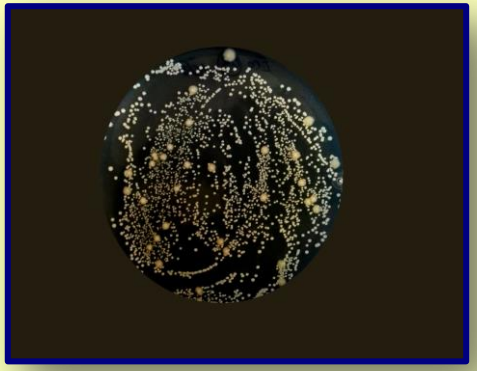
Super Ravo Zapper

Claims:

- function generator with adjustable frequency
- killing bacteria, viruses, pathogenes,...
- frequency choice according to “internet” tables
- youtube videos of blowing cells

Our findings:

- non-existence of setup parameters for experiments
- 2 types of bacteria (E. coli a B. subtilis) with application of their supposed resonant frequencies obtained from the tables
- no killing; no reduction of cultivated populations



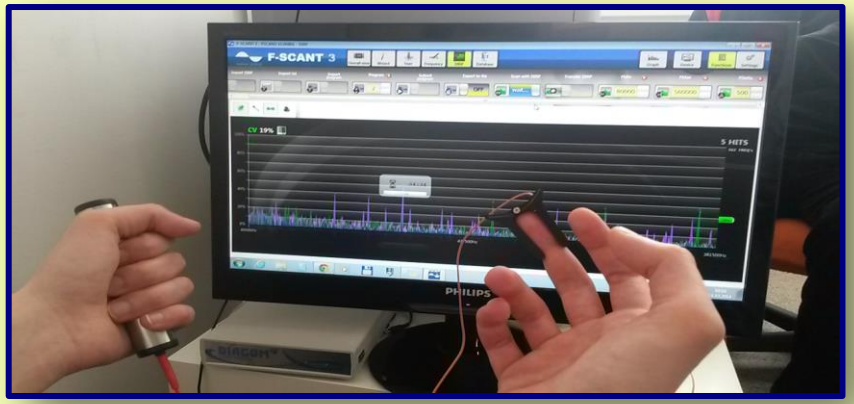
F-scan

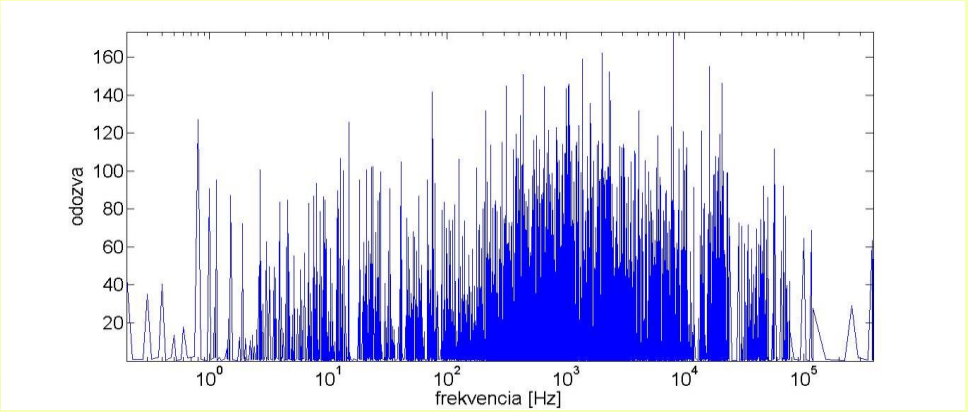
Claims:

- uses resonating frequencies to investigate the state of the human body
- detects the frequency (Hz - MHz) at which infections, viruses and other forms of illness resonate, then ‘zaps’ the target at an exact frequency
- enabling the user to target and treat cells without damaging any surrounding tissue

Findings:

- simulation: random choice of frequencies and it’s amplitudes over the whole interval. Average distance between 2 peaks ~ “allowed” peak fluctuation
- estimate of time needed for discovering 10 000s frequencies: thousands of years





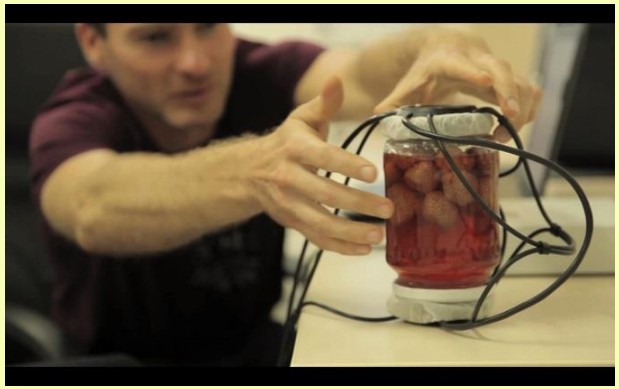
Metatron

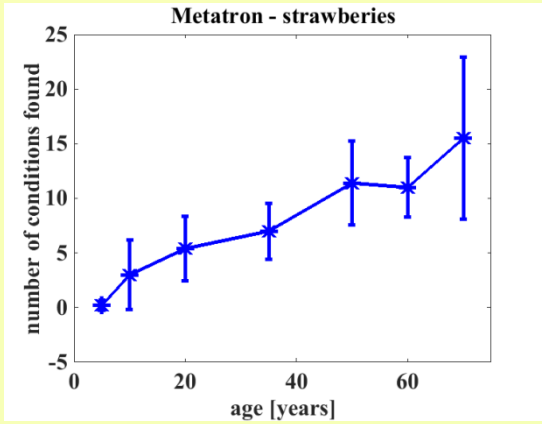
Claims:

- “Non-linear analysis systems tracing any conditions in the body through changes in the wave characteristics of tissues. The diagnosis equipment is based on the spectral analysis of the vortex magnetic field of any biological object.”
- “Makes an evaluation of the organ condition directly due to the resonance amplification of the radiation signal of the organ under investigation using a non-invasive trigger sensor. Every organ and every cell has its own distinctive oscillations which are stored in the computer memory”
- “Able to record the frequency patterns of any remedy (Hz-MHz)”
- “Therapy: system searches for a remedy that has the closest spectral characteristics of the pathological process”

Metatron - findings

- ordinary audio head set
- Info from patent: “based on brain EEG bioelectrical activity” - impossible
- impossible spatial resolution
- intelligent recognition of patient: simple pressure sensor
- reproducibility: adjusting to age, gender, previous data from the same patient
- male with female reproduction system problems
- stewed strawberries “3-70 years old”: human diagnoses; increasing number of pathologies with age
- patient and strawberries under the same name: almost the same results
- → expert knowledge is imitated by the software





Bioresonance devices – our evidence

- surprising inconsistencies from the very beginning of investigation
- we have considered all possible measurement principles: impedance spectroscopy, biopotentials (~EEG), contactless RF antena
- looking for a source of bio EM signal from the body in respect to the measurement technology: implausible
- excuses ending up with unmeasurable claims: impossible to disprove
- documentary film – teaser: youtube “INVESTIGATORS - Bioresonance”

How to distinguish evidence based from alternative?

- extraordinary claims require extraordinary evidence
- Hitchens's razor: "What can be asserted without evidence can be dismissed without evidence.“
- Occam’s razor: explain the phenomena by the simplest hypothesis possible
- present world: business dominates – many start-ups accelerates their products without proper evidence; with simplification, extrapolation
- Credibility criteria:

  reproducible results

  backing by specialists with sufficient reputation and expertise

  peer review studies

  disclosed technicalities: measurement principles, graphs, signals

Critical assessment of tumor specific EM frequencies

- approach by group of Boris Pasche (TheraBionic)
- Barbault et al. Amplitude-modulated electromagnetic fields for the treatment of cancer: Discovery of tumor-specific frequencies and assessment of a novel therapeutic approach (2009).
- resemblance to alternative medicine: business precedes justified science
- historical perspective - EM frequency therapy developed for treatment of insomnia: no successful spread of application, published results: statistical significance can be argued due to possible bias (non equal average values in test and control group)

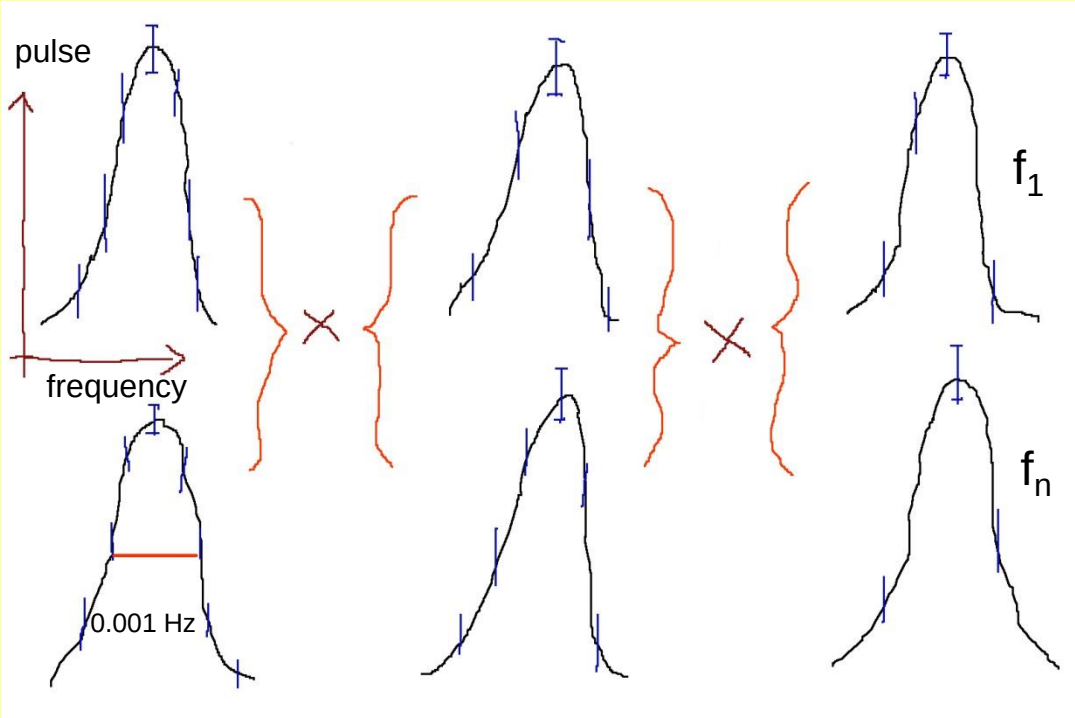
Critical assessment of tumor specific EM frequencies

- 1524 frequencies, 0.1 - 114 kHz, precision: 423.321 Hz, 60317.352 Hz: incredible quality factor $f/\Delta f \sim 10^{6-8}$!
- long list of frequencies: resembles alternative medicine bioresonances

4718.331 Hz	8642.181 Hz
4749.302 Hz	8655.818 Hz
4765.331 Hz	8758.341 Hz
4917.202 Hz	8779.323 Hz
5011.325 Hz	8792.231 Hz
5149.331 Hz	8819.127 Hz
5228.172 Hz	8831.132 Hz
5237.132 Hz	9028.031 Hz
5313.353 Hz	9173.264 Hz
5745.218 Hz	9184.338 Hz
5757.897 Hz	9186.919 Hz
5762.386 Hz	9393.946 Hz
5812.322 Hz	9482.409 Hz
5869.321 Hz	9737.211 Hz
5882.292 Hz	9746.232 Hz
5921.249 Hz	9922.231 Hz
5991.932 Hz	10032.684 Hz
6069.458 Hz	10446.028 Hz
6071.319 Hz	10478.221 Hz
6083.214 Hz	10545.313 Hz
6161.782 Hz	10639.345 Hz

Critical assessment of tumor specific EM frequencies

- frequency determination: the greatest increase in radial pulse strength and/or pulse rate were selected as tumor-specific frequencies



single patient | single patient reproducibility intrapersonal variability | multiple patients interpersonal variability

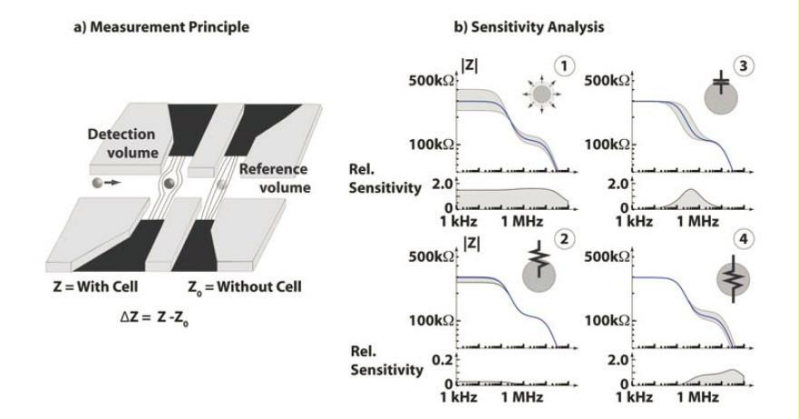
Critical assessment of tumor specific EM frequencies

- used physiological parameters are not stable, depending on many physiological and psychological variables
- justification with physical model by non-independent expert (Blackman):
  Ca ion mechanism: resembles reasoning of alternative medicine with irrelevant and unsupported physical claims
- over 50% of papers in psychology and biomedical sciences are biased
- known examples of treatment approaches that collapse only in the last stage of clinical trials

	evidence based	publications	patents	basic principles	proprietary/sec-ret informations
alternative medicine	missing	missing	yes	unknown	yes
TheraBionic	missing key evidence	missing key evidence	yes	unknown	yes

Our contribution in search for specific frequencies

- development of an automatic procedure for monitoring of biological response to weak LF EMF
- new experimental approach should enable efficient scanning through EMF parameters – frequency and amplitude - while searching for specific responses of the investigated biosystem
- Methods based on the electrical impedance spectroscopy:
  - growth rate of cell cultures (S. cerevisiae) in an aqueous medium
  - single cell electrical properties in EIS chips – measurable changes in cell size, membrane R, C; intracellular R.
  - nonlinear dielectric properties



Valero: A unified approach to dielectric single cell analysis: Impedance and dielectrophoretic force spectroscopy, 2010

Conclusions

- theoretical reasons for resonances: YES
- experimentally (confirmed) evidence: NO

- seemingly strong clinical effects in alternative medicine might be often explained by:
  - bias due to fakes, artefacts, or misinterpretation
  - mistakes of argumentation, logical fallacies, and cognitive bias
  - enhanced placebo effect

- search for resonances is going on:

Call for collaboration