

Effect of Schumann Resonance on Cardiac Function

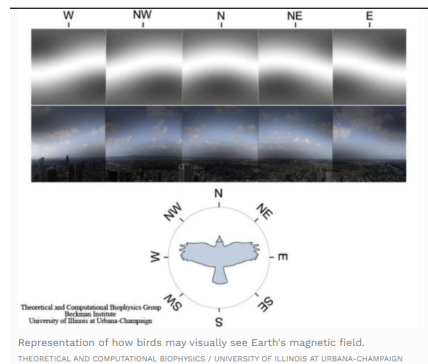
1.0 Introduction

Many consider the effects of Schumann Resonance (SR) as “New age” and has not been fully adapted by mainstream science. This is slowly changing, as there has been many scientific publications showing the effects of Magnetic Fields on biological function. This paper has a brief discussion on how magnetic field interacts with biological functions. Then a detailed analysis is done on a recently published paper in nature magazine (2019) which analyses the protective nature of SR on biological heart rhythms: “Cardio protection from stress conditions by weak magnetic fields in the Schumann resonance band”. Then a study of electromagnetic interference from small scale and large-scale electronics is done to see how much a person is exposed to on a daily basis. Based on what is learned in this publication and using scientific principles, an analysis is done on a SR generator to see its effectiveness.

Schumann resonance (SR) results naturally from a cavity between the earth’s crust and its ionosphere, predicted mathematically and measured imperially, it has been linked to many different effects on biological systems and nature such as: Bioregulation, brainwave entrainment, and Bio-proliferation. Most studies have been done on the fundamental SR frequency of 7.83 Hz. The strength of this frequency is approximately 300 uV/m or 1 pT, which is nine orders (1 million) of magnitude lower than the earth Geomagnetic field (25 uT).

The first question to ask is, do magnetic fields affect biology? The ability to detect and orient to magnetic fields has been observed in bacteria, algae, invertebrates and vertebrates, including birds, rodents and amphibians. A paper published in Nature magazine in 2017 (Insight into shark magnetic field perception from empirical observations) showed Unimpaired, conditioned sharks produced a 100% response (all sharks demonstrating a conditioned response) to an applied magnetic field intensity used in training and conditioning, which ranged from 0.03 to 3.0 micro-Tesla (μ T). The Geo-magnetic field parameters provide useful information about direction and orientation. The mechanism on how a magnetic field interacts with biological transducer is still being investigated. Two recent studies (2018) from researchers at Lund University in

Sweden and Carl von Ossietzky University Oldenburg in Germany showed a special protein in bird's eyes interacts with magnetic field. The two papers studied European robins and found evidence for an unusual eye protein called Cry4. Based on their finding they extrapolated a model showing how a robin uses this as a heads-up display shown in the figure below:



There is a lot of research showing casual effects on biology from magnetic fields. Nature has in cooperated the use of magnetic fields to design its creation.

2.0 Review of Research paper “Cardio protection from stress conditions by weak magnetic fields in the Schumann Resonance band”

This study published in Nature magazine in 2019 shows the effect of SR on rat cardiac cell culture. Testing is done by removing the heart of a rat and measuring the spontaneous contractions that result from calcium transient in cardiac rhythm, which is similar to how human hearts work. Calcium ion transients are the key mediators between the mechanical contractions and the cardiac action potentials which initiate the contractions. The following YouTube video shows how the calcium transient in a heart works (2 min mark)

<https://www.youtube.com/watch?v=v7Q9BrNfipQ>. Intuitively a simple understanding of this is a heart which has pace maker cells create an oscillation (heart rate) by balancing Sodium (Na), Calcium (Ca), and Potassium (K+). The paper looks at the Ca concentrate affected by the Schumann Resonance. Testing is done in three different scenarios where they apply the SR on cultures in a) Normal condition: Apply SR for 40 min, b) Hypoxic condition (1 hour of SR, then 2 hours hypoxic (Oxygen starved) c) Oxidative stress (imbalance of free radicals and antioxidants), 1.5 hour of SR, 1 hour of Oxidative stress. In each of these scenarios they measure Calcium amplitude which represent the strength of the heart rate contraction. There test results show very interesting interaction with the SR:

- 1) SR group increased Ca contraction rate 200 % in the first 20 min and up 400% after 40 min.
- 2) SR has a positive effect in both oxidative stress and hypoxic condition as it shows 40~70 % increased protection compared to the control group.
- 3) Frequency between 7.4 to 8.3 Hz had an effect. While 7-7.4 Hz and 8.4 to 8.6 Hz did not affect the sample.
- 4) 20 pT and 100 nT has similar results which shows that a small amount of magnetic field has the same effect at large amount.
- 5) Adding 10 uT of Static (0 Hz) magnetics field on top of the SR has a negative effect on the Ca ion, shows that external DC electromagnetic interference has a negative impact on heart rate

Fundamentally this paper shows SR has a positive effect on heart rate contraction and has a protective effect. The SR might resonate with Ca ions which play a big role in human biological regulation functions. Another interesting effect is that an external 10 uT DC Static magnetic field has a negative effect on heart rate. So we are prone to interference from magnetic fields at a chemical level.

3.0 How much Electromagnetic noise interference does manmade devices create?

Now that there is evidence which shows the effects of magnetic field on biological function the next question is to understand how much electromagnetic noise electronics devices make. Electromagnetic noise can be characterized as ionizing (energy which can detach electrons) and non-ionization. We are mostly protected from ionizing energy from our ionosphere. The non-ionization energy can be either Static (0 Hz) or Alternation magnetic field (>0 Hz). These are classified in weak (<1 mT), moderate (1mT to 1T) and high (1T to 20 T) and ultra-high (>20 T). Most large-scale electronics including AC power lines, High voltage (100kV to 800kV) DC line (HVDC) has leakage. The table below shows typical magnetic field strength leakage for electronics devices. For comparison earth's geomagnetic fields (GMF) is approximately 25 uT at the equator to 65 uT at the poles.

Devices	Static or Alternating	Class	Strength	Comments
HVDC (High Voltage DC)	Static	Weak	22 uT to 38 uT	
GMF (Geomagnetic Field)	Static	Weak	Min:25 uT at the equator Max: 65 uT at the pole	Earth's magnetic field
DC trains	Static	Weak	1 mT	
Levitation Trains (High speed)	Static	Moderate	10 mT	
Hybrid Cars	Alternating	Moderate	Up to 0.95 T	
Small electronics	Alternating	Weak	50 uT to 90 uT	Portable electronics
MRI	Static/Alternating	Moderate	100's mT	
MRI 7T	Static/Alternating	High	2.89 T	Latest 7 T MRI machine

The commission on Non-Ionizing Radiation Protection (ICNIRP) states 400 mT for the public is considered safe and it is not expected to pose a risk to health. These are based on short term studies. Recent research on the effect of static weak magnetic fields shows issues with melatonin biosynthesis, cardiovascular functioning, including blood velocity, blood pressure and heart rate. For high magnetic fields strengths in Tesla range, the most common reported effects of exposure were transient symptoms such as vertigo, nausea, magnetic phosphenes, and a metallic taste in the mouth

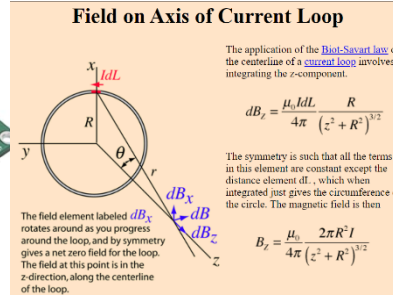
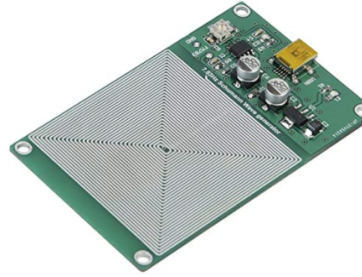
In my past I have designed radio frequencies products from 4 MHz to 5 GHz. The maximum power these devices can emit is limited by FCC guidelines for cell phone and portable body worn wireless electronics. These limits are based on SAR (Surface Absorption Rate), which puts a limit on the amount of degree temperature rise on a volume's tissue for a duration of time. These limits do not take into consideration the long term effects at a chemical level. The limits are based on resonate cavity and boundary conditions of the human body. Other Alternating noise can result from AC power lines and household electronic. These are measured <https://www.srpnet.com/electric/emf.aspx> and shown in the table below:

Electric devices (Alternating)	0.5 foot	1 foot	2 foot	4 foot
Hair Dryers	0.01-70 uT	1-70uT	1uT	0.1 uT
Vacuum Cleaners	10-70uT	2.0-20uT	0.4-2 uT	0.1-1 uT
Microwave (60Hz)	10-30uT	0.1-20uT	0.1-3uT	0.2-2 uT
Irons	0.6-20 uT	0.1-0.3 uT	-	-
TV		0.7-2 uT	0.2-0.8 uT	0.4 uT
Directly under overhead transmission line	0.5 to 10 uT			
100 feet away from overhead transmission line	0.1 to 2 uT			
Directly over underground distribution lines	0.6 to 3 uT			
20 feet away from underground distribution lines	0.2 to 1uT			

Based on the above measured data, one can easily be affected by interference level of 10 uT which shows to have a negative effect on cardiac function. The next step is to look at the current Schumann resonance generator on the market to see its effectiveness.

4.0 Schumann resonance generator currently on the market.

I bought the following SR Generator. The magnetic field this create can be calculated using Biot-Savart law shown below (Bz)



Parameter	Value	Comments
Voltage	5 V	
Current	0.1 A	
Coil size	3 x 3 in, 30 turns, 1.5 uH inductance	1.5 uH is an approximation
Resistance of coil	5 ohms	Approximate
Distance where Magnetic Field in Axial Direction is 10 pT (Boit-Savart law)	About 3-4 meters	Assumption all 30 loops are same size.
Protection range	About 2-3 meters	This does not take into consideration the Signal to Noise ratio of Interference signal.

This device has a range of approximately 2 to 3 meters where the intensity of the magnetic field reaches the lower limit of 10 pT as shown by the research paper. It is also interesting to note that depending on the strength of the interference signal, the range will be lower. There experiment was done with 90 nT of SR and 10 uT of Interference signal which is approximately 1000x larger.

5.0 Summary

This paper shows there is enough evidence to see a direct correlation with the effects of the magnetic field on biological function. Investigation of how the SR effect biological heart function shows evidence of its protective nature. A study of electromagnetic interference from human made technology shows there is enough leakage of electromagnetic energy which can cause interference with normal biological function. An investigation of an external SR generator show it can provide protection from electromagnetic interference in close proximity provide the interference signal is not to strong.

6.0 Reference

<https://www.nature.com/articles/s41598-018-36341-z> "Cardioprotection from stress conditions by weak magnetic fields in the Schumann Resonance band"

<https://www.brmi.online/post/2019/09/20/schumann-resonances-and-their-effect-on-human-bioregulation>

<https://www.nature.com/articles/s41598-017-11459-8> "Insight into shark magnetic field perception from empirical observations"

<https://www.forbes.com/sites/trevornace/2018/04/04/we-finally-know-how-birds-can-see-earths-magnetic-field/?sh=3893baed20e1>

<https://www.sciencemag.org/news/2016/06/body-s-hidden-compass-what-it-and-how-does-it-work> "The bodies hidden compass"

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0230038> "Biological and health-related effects of weak static magnetic fields (≤ 1 mT) in humans and vertebrates: A systematic review"

<https://www.youtube.com/watch?v=v7Q9BrNfIpQ&app=desktop> "Cardiac Action Potential, Animation"

<https://srpnet.com/electric/emf.aspx> "Measured Electric and magnetics field from power lines and house hold electronics"

<http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/curloo.html> "Magnetic field of current loops"