

# So much research, yet so little notice taken

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I will talk mainly about the health effects of power frequency and other low frequency magnetic fields

— the so-called ELF-EMF

and I will try to relate this to Electro-sensitivity

I want to bring out just how much we know, but how whole areas of the science are ignored

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When the Earth was formed, 4.5 billion years ago, magnetic fields were already present, indeed had been so since the Big Bang some 7 billion years earlier.

Life eventually formed on Earth (birds 200 million years ago) and the indications are that at least 50 animal species learned to detect tiny changes, of the order tens of nano-tesla, in the Earth's magnetic field for the purposes of navigation.

Man may or may not have used the magnetic field seen on Earth (the Geomagnetic field or GM-field) for navigation but modern day research suggests that they sense small changes in magnetic fields brought about by Solar and Geomagnetic Activity.

## Health and fluctuations in solar and geomagnetic fields (GM) – Review by Palmer *et al.* Surv Geophys 27; 557-595, 2006

- The Earth has a static magnetic field  $\sim 48 \mu\text{T}$  in the UK
- However, there are short-term fluctuations derived from solar flares
- Of particular interest are fields varying up to  $0.3 \mu\text{T}$  over a 3 hour period
- Evidence suggests that 10-15% of the population were predisposed to possible health effects such as: **cardiovascular health, depression & suicide and melatonin disruption**

...and it is the **fluctuations** that are of special interest

Zhadin MN. 2001. Review of Russian Literature on Biological Action of DC and Low-Frequency AC Magnetic Fields. *Bioelectromagnetics* 22:27-45.

#### GMA & melatonin disruption

Bartsch H, Bartsch C, Mecke D, Lippert TH. 1994. Seasonality of pineal melatonin production in the rat: Possible synchronization by the geomagnetic field. *Chronobiology International* 11:21-26.

Burch JB, Reif JS, Yost MG. 1999. Geomagnetic disturbances are associated with reduced nocturnal excretion of a melatonin metabolite in humans. *Neuroscience Letters* 266:209-212.

Bergiannaki J.-D, Paparrigopoulos TJ, Stefanis CN. 1996. Seasonal pattern of melatonin excretion in humans: relationship to day length variation rate and geomagnetic field fluctuations. *Experientia* 52:253-258.

Weydahl A, Sothorn RB, Cornélissen G, Wetterberg L. 2001. Geomagnetic activity influences the melatonin secretion at latitude 70° N. *Biomed. Pharmacother*, 55:57-62.

Berk M, Dodd S, Henry M. 2006. Do ambient electromagnetic fields affect behaviour? A demonstration of the relationship between geomagnetic storm activity and suicide. *Bioelectromagnetics* 27:151-155.

Gordon C, Berk M. 2003. The effect of geomagnetic storms on suicide. *South African Psychiat Rev* 6:24-27.

Partonen T, Haukka J, Nevanlinna H, Lonnqvist J. 2004. Analysis of the seasonal pattern in suicide. *Journal of Affective Disorders* 81:133-139.

#### Depression & mental disorder:

Kay RW. 1994. Geomagnetic Storms: Association with incidence of depression as measured by hospital admissions. *British Journal of Psychiatry* 164:403-409.

Kay RW. 2004. Schizophrenia and season of birth: relationship to geomagnetic storms. *Schiz Res* 66:7-20.

Persinger MA. 1987. Geopsychology and geopsychopathology: Mental processes and disorders associated with geochemical and geophysical factors. *Experientia* 43:92-104.

Raps A, Stoupel E, Shimshani M. 1991. Solar Activity and admissions of psychiatric inpatients, relations and possible implications on seasonality. *Israelis Journal of Psychiatry and Related Science*. 28:50-59.

#### A4 Heart rate:

Belov DR, Kanunikov IE, Kisley BV. 1998. Dependence of Human EEG spatial synchronization on the Geomagnetic Activity on the Day of Experiment. [in Russian]. *Ross Fiziol Zh Im I M Sechenova*, 84:761-774.

Cernouss S, Vinogradov A, Vlassova E. 2001. Geophysical Hazard for Human Health in the Circumpolar Auroral Belt: Evidence of a Relationship between Heart Rate Variation and Electromagnetic Disturbances. *Natural Hazards* 23:121-135.

Dimitrova S, Stoilova I, Cholakov I. 2004. Influence of local Geomagnetic Storms on Arterial Blood Pressure. *Bioelectromagnetics* 25:408-414.

Otto W, Hempel WE, Wagner CU, Best A, 1982. Various periodical and aperiodical variations of heart infarct mortality in the DRG – [In German] ]. *Z Gesamte Inn Med (Zeitschrift für die Gesamte innere Medizin und ihre Grenzgebiete)* 37:756-763.

Srivastava BJ, Saxena S. 1980. Geomagnetic-biological correlations – Some new results. *Ind J Radio Space Phys.* 9:121-126.

Stoupe E. 2002. Editorial: The effect of geomagnetic activity on cardiovascular parameters. *Biomedicine & Pharmacotherapy* 56:247s–256s.

Ghione S, Mazzasalma L, Del Seppia C, Papi F. 1998. Do geomagnetic disturbances of solar origin affect arterial blood pressure? *Journal of Human Hypertension*, 12:749-754.

#### Light sensitivity

Cremer-Bartels G, Krause K, Kuchle HJ. 1983. Influence of low magnetic field-strength variations on the retina and pineal gland of quail and humans. *Graefe's Archive for Clinical and Experimental Ophthalmology (Graefe's Arch Clin Exp Ophthalmol)*, 220:248-252.

Partonen T. 1998. Short note: Magnetoreception attributed to the efficacy of light therapy. *Med Hyp* 51:447-448.

Thoss F, Bartsch B, Telschaft D, Thoss M. 1999. Brief communication: Periodic inversion of the vertical component of the Earth's magnetic field influences fluctuations of visual sensitivity in humans. *Bioelectromagnetics* 20:459-461.

Thoss F, Bartsch B, Fritzsche B, Telschaft D, Thoss M. 2000. The magnetic field sensitivity of the human visual system shows resonance and compass characteristic. *Journal of Comparative Physiology A: Sensory, Neural, and Behavioral Physiology* 86:1007-1010.

Thoss F, Bartsch B, Fritzsche B, Telschaft D, Thoss M. 2002. The light sensitivity of the human visual system depends on the direction of view. *Journal of Comparative Physiology A*: 188:235-237.

Thoss F, Bartsch B. 2003. The human visual threshold depends on direction and strength of a weak magnetic field, *Journal of Comparative Physiology A: Sensory, Neural, and Behavioral Physiology*, **189**:777 – 779.

#### Schumann resonances

Schumann WO. 1952. Über die strahlungslosen Eigenschwingungen einer leitenden Kugel, die von einer Luftschicht und einer Ionosphärenhülle umgeben ist, *Z. Naturforsch* **7a**, 149.

Schumann WO, König HL. 1954. Über die beobachtung von atmosphärischen bei geringsten frequenzen, *Naturwissenschaften* 41:183.

Cherry N. 2002. Schumann Resonances, a plausible biophysical mechanism for the human health effects of Solar/Geomagnetic Activity. *Natural Hazards*, **26**, 279-331.

Cherry N. 2003a. Human intelligence: The brain, an electromagnetic system synchronized by the Schumann Resonance signal. *Med. Hypotheses*, **60** (6), 843-844.

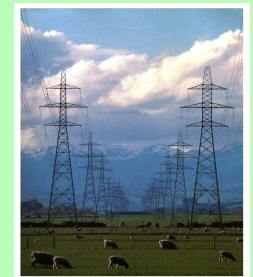
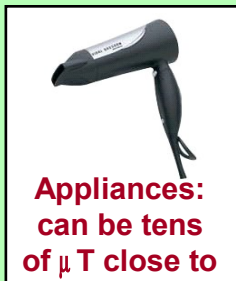
Cherry N. 2003b. Schumann Resonance and Sunspot Relations to Human Health Effects in Thailand. *Natural Hazards*, **29**: 1-11.

<b>Table 1.</b> Animals demonstrated to use a magnetic compass				<b>Type of compass</b>
Systemic group				
<b>Molluscs</b> Snails	1 order	1 family	1 species	???
<b>Arthropods</b> Crustaceans Insects	3 orders 6 orders	3 families 7 families	5 species 9 species	polarity compass polarity compass?
<b>Vertebrata</b> Cartilaginous fish Bony fish Amphibians Reptilians Birds Mammals	1 order 2 orders 1 order 1 order 4 orders 2 orders	1 family 2 families 2 families 2 families 12 families 2 families	1 species 4 species 2 species 2 species 21 species 3 species	??? polarity compass? inclination compass inclination compass inclination compass polarity compass

Table 1 taken from; Wiltschko R & Wiltschko W 2006. Magnetoreception. BioEssays 28:157-168.



# Power frequency electric & magnetic fields - especially magnetic fields, MFs



Under powerlines MFs can be several  $\mu$  T or evens tens of  $\mu$  T

Doubling of CL risk associated with  
0.3/0.4  $\mu$  T

Average MF home levels 0.05  $\mu$  T

**Review bodies' assessments of EMF causation of various diseases.  
- health outcomes classified as Class 2B - possible causal.**

Disease	IARC <sup>1</sup> 2002	NIEHS 1999 <sup>2</sup>	California 2002	EU: SCENIHR <sup>3</sup> February 2009
1. Childhood Leukaemia	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
2. Adult Leukaemia		<b>Yes</b>	<b>Yes</b>	
3. Adult brain cancer			<b>Yes</b>	
4. Miscariage			<b>Yes</b>	
5. ALS <sup>4</sup>			<b>Yes</b>	
6. Alzheimer's disease				<b>Yes<sup>5</sup></b>

<sup>1</sup>International Agency for Research on Cancer

<sup>2</sup>US National Institute of Environmental Sciences

<sup>3</sup>EU: Scientific Committee on Emerging and Newly Identified Health Risks:  
Possible effects of Electromagnetic Fields (EMF) on Human Health.

<sup>4</sup>Motor neurone disease

<sup>5</sup>Studies only recently published

A Compilation of Surveys Conducted Throughout Stoke-on-Trent

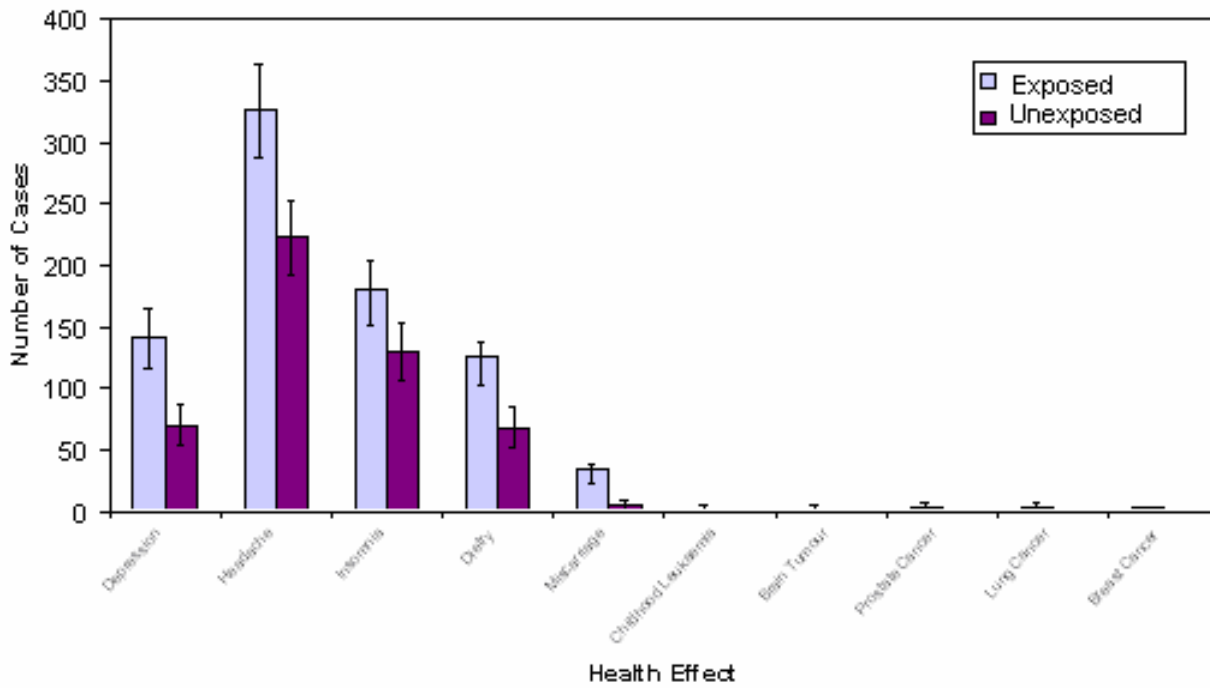


Table 1: Pooled findings from three surveys from the Stoke-on-Trent area (Males and females combined and scaled for equal number of questionnaire from exposed and unexposed residents)

## TRENTHAM ENVIRONMENTAL ACTION CAMPAIGN

### Males and Females - Pooled from all 3 surveys

	Within 25 m of powerline	Controls group*
Total number of questionnaires issued	-	-
Total number of questionnaires returned	-	-
<b>Depression:</b>		
Total reported	164	71
No. requiring doctor	38	3
No. requiring hospital	11	2
<b>Headache:</b>		
Total reported	381	223
No. requiring doctor	22	5
No. requiring hospital	4	2
<b>Insomnia:</b>		
Total reported	209	130
No. requiring doctor	17	4
No. requiring hospital	3	-
<b>Dietary:</b>		
Total reported	140	68
No. requiring doctor	26	5
No. requiring hospital	17	1
<b>Miscarriage</b>		
	38	5
Childhood Leukaemia	2	
Brain Tumour	5	
Prostate Cancer	4	
Lung Cancer	3	
Breast Cancer	4	
Hodgkin's Lymphoma	1	

\* The controls consisted of a group of people residing further than 150 metres from the 132 kV powerline.

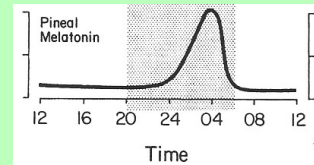
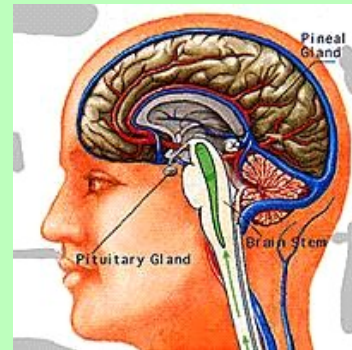
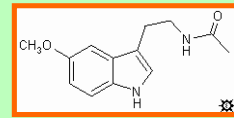
## Illnesses associated with EMFs – Is there a common factor?

- Childhood leukaemia
- Adult leukaemia
- Adult brain cancer
- Breast cancer
- ALS (motor neurone disease)
- Alzheimer's disease
- Miscarriage
- Depression
- Suicide

Disruption of  
**Melatonin**

## Melatonin (N-acetyl-5-methoxytryptamine)

- Melatonin is a hormone produced in the pineal gland mainly at night
- Ganglion cells in eye (not visual system) signal when there is **no light** – pineal melatonin produced at night
- Highly protective of oxidative damage to the human haemopoietic system
- Reduced levels of melatonin are associated with (i) increased cancer risk in animals and in humans, (ii) with depression and possibly miscarriage



## Light at Night - Europe in the Present



<http://www.ngdc.noaa.gov/dmsp/>

- **The Melatonin Hypothesis** – Richard Stevens University of Connecticut 1987
- Exposure to light-at-night or MFs suppresses nocturnal melatonin leading to increased risk of breast cancer
- Has much support for **visible light**: evidence that female night shift workers have elevated breast cancer risk (Review by Megdal *et al.* Eur J Cancer 41: 2023-2032, 2005)
- 2007: IARC has classed night shift work as a **Class 2A**, “probable” carcinogen
- Populations exposed to neighbourhood **EMFs shown melatonin disruption with fields as low as 0.2  $\mu$ T** (Review by Henshaw & Reiter, Bioelectromagnetics S7: 86-97, 2005)

## Biophysical mechanisms – Animal navigation

- Many animals can detect and use tiny changes in the Earth's 'static' magnetic field – both its **strength** and **orientation** – for navigation
- Robins detect changes of 80 nT (Ritz, 2004) and homing pigeons sensitive to 10-20 nT (Wiltschko, 2005)
- A magnetometer consisting of **magnetite** particles in beak
- A compass in the eye
- Some amphibians have receptors in **pineal gland...**



# Behavioural responses to variable fields

- ▶ Birds are able to detect tiny changes in the geomagnetic field down to 10 nT resolution in the Earth's static field  $\sim 50 \mu\text{T}$
- ▶ Migalski *et al.* (2008) demonstrated how the pigeon can respond to the cancellation of the Earth's static field

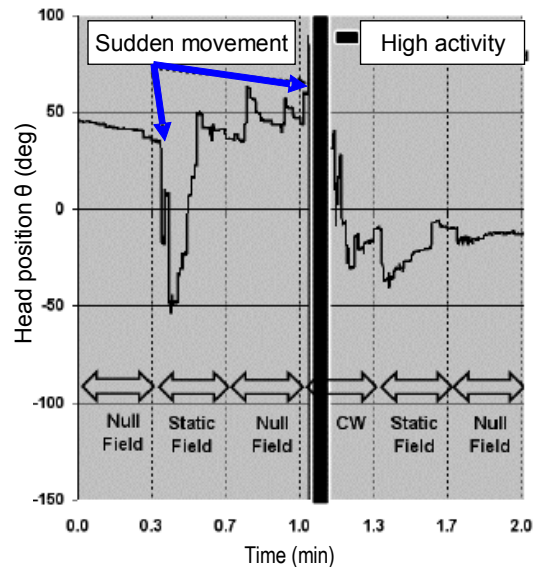
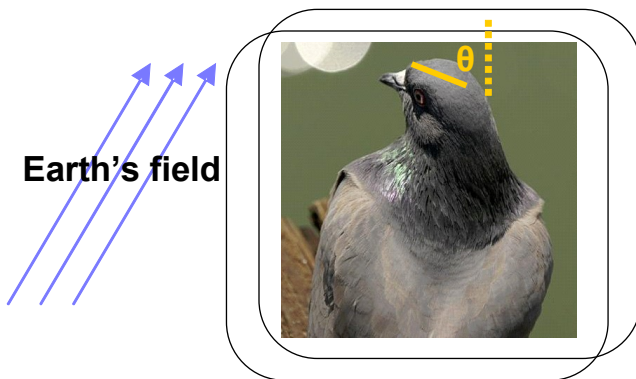
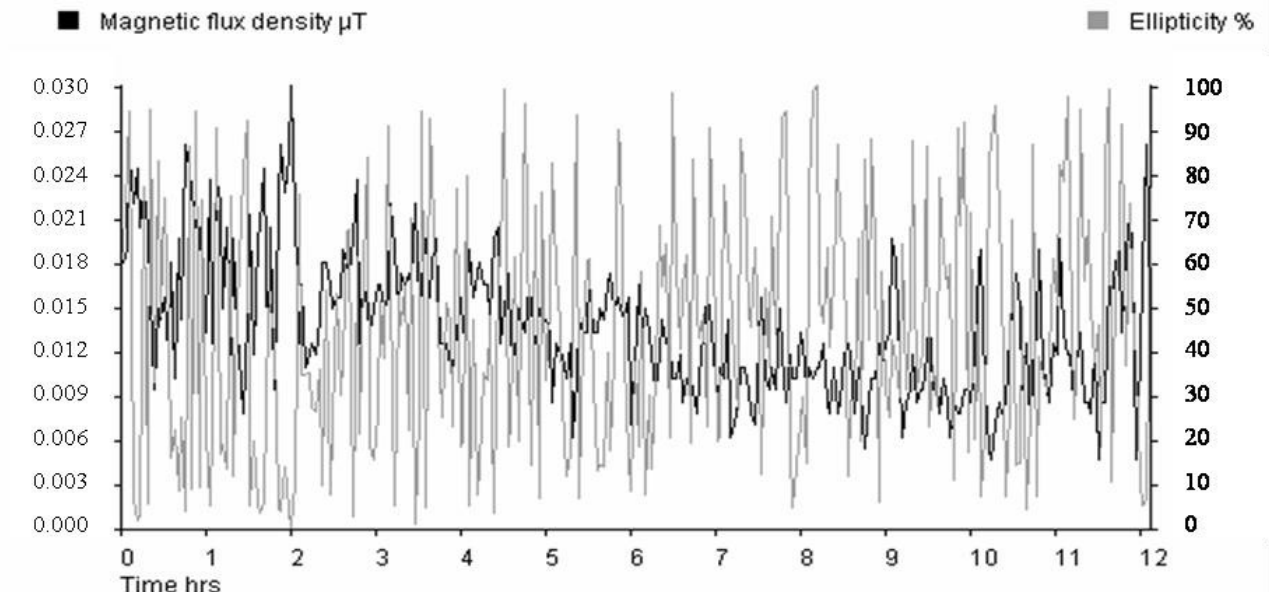


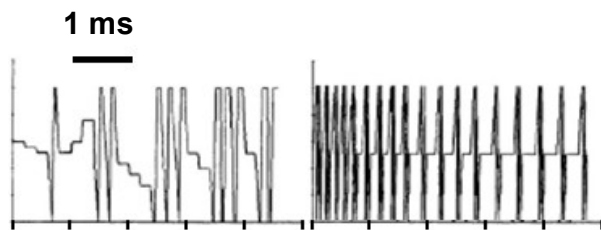
Figure 1. Graph showing the analysis of the change in bird's head position vs. time, where bird was exposed to different magnetic field conditions (CW-field sweeping clockwise)

Migalski, S. *et al.* 2008. Developing a behavioural assay of magnetic field sensitivity in homing pigeons: Is it a question of vision? Abstract from Royal Institute of Navigation conference 2008

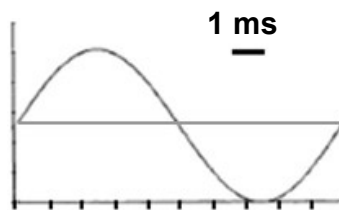
The graph show the typical time profile of indoor magnetic fields in a house in Bristol. The average field is only  $\sim 0.015 \mu\text{T}$  but there is a substantial switching content.



# Patterned magnetic fields



Patterned fields – higher RCM



5 Hz pure sine wave

- ▶ Patterned MF associated with increased number of cellular anomalies fields as low as  $0.09 \mu\text{T}$

- ▶ Lee *et al.* (2002) and Li *et al.* (2002) - higher odds ratios for miscarriage for RCM compared to TWA

St-Pierre, L.S. *IJRB*. 2008. **84**(4): 325-335

Lee, GM. *et al.* *Epidemiology*. 2002; **13**: 21-31.

Li, D. *et al.* *Epidemiology*. 2002; **13**: 9-20.

## Conclusions

In my estimation, official review bodies have cited less than 10% of the available scientific evidence relating to ELF-EMF effects. In some areas, none of the literature has been cited.

Some example subject areas

<b>Subject area</b>	<b>No of papers</b>
Health from S-GMA	~50
Animal navigation in GM-field	~6,000?
Magnetoreception in plants	~700?
Ion cyclotron resonance, ICR	>150
Persinger et al	>400
Other authors	100?