

Sources Electro Smog

Credit: Philip Ronan, Gringer, 2016

Picture Source:

#EM spectrumrevised.png, 2013

https://commons.wikimedia.org/wiki/File:EM_spectrumrevised.png

On the left side is the radiation with the shortest waves, on the right side that with the longest ones. The shorter the waves are or the higher their frequency is, the more energy they transmit and the more potentially dangerous they are.

– Radiation with very short wavelengths, like UV light, x-rays and gamma rays are strong enough to rip electrons out of their atoms which can cause burns and genetic damage.

Electromagnetic waves with a wavelength shorter than approximately 250 nanometer (that means on the left side of the spectrum) are so energetic that they can rip electrons out of their atoms. This sort of radiation is called ionizing radiation and is dangerous to humans, because it can cause damage to our cells and genes.

What is ionizing radiation?, 2018

https://www.who.int/ionizing_radiation/about/what_is_ir/en/

– The rest of the spectrum covers a large range of longer waves, from visible light, infrared, microwaves to radio waves.

All radiation with a wavelength longer than 250 nanometers is not able to cause damage in our genes and cells and is called non-ionizing radiation.

Non-ionizing radiations – Sources, biological effects, emissions and exposures, 2004

<https://www.who.int/peh-emf/meetings/archive/en/keynote3ng.pdf>

#Radiation Basics, United States Environmental Protection Agency, 2018

<https://www.epa.gov/radiation/radiation-basics#ioniandnonioni>

– Some kinds of radiation can stimulate muscles and nerves and can also make the hair on your body vibrate, which can sometimes cause a tingly feeling above certain threshold values.

#Electromagnetic fields and public health, WHO, 2007

<https://www.who.int/peh-emf/publications/facts/fs322/en/>

#Electromagnetic fields at workplaces. Final report, 2011

http://www.bmas.de/SharedDocs/Downloads/DE/PDF-Publikationen/fb400e-elektromagnetische-felder-englisch.pdf?__blob=publicationFile

– Microwaves push the water molecules in your food around, which warms it up.

In fact, microwaves have an impact on other molecules as well, but the effect works best on water molecules, since they are particularly charged. The oxygen atom has a negative charge and the two hydrogen atoms a positive one. This is why the molecule spins around according to the direction of the microwaves' field strength. The field strength constantly changes its direction and the orientation of the water molecules with it. This friction is what creates the heat.

#How Do Microwaves Work?, Encyclopedia Britannica, 2018

<https://www.britannica.com/story/how-do-microwaves-work>

#Microwaves, Encyclopedia Britannica, 2018

<https://www.britannica.com/science/electromagnetic-radiation/Microwaves#ref307310>

– For example, the pleasant warmth you feel at the beach is your skin heating up from exposure to electromagnetic infrared radiation from the sun.

#How exactly does light transform into heat--for instance, when sunlight warms up a brick wall?, retrieved 2019

<https://www.scientificamerican.com/article/how-exactly-does-light-tr/>

#What are the risks of non-ionising radiation?, retrieved 2019

<https://www.nwo-i.nl/en/personnel/working-conditions/radiation/non-ionising-radiation/what-are-the-risks-of-non-ionising-radiation/>

– The question if this is actually dangerous to us first got public attention when a 1979 study linked leukemia to living near power lines.

The study of Wertheimer and Leeper was the first one to find an association between electromagnetic radiation and cancer. Different kinds of cancer in childhood were examined, including leukaemia, brain tumors and lymphomas.

Electrical wiring configurations and childhood cancer, in American Journal of Epidemiology, Volume 109, Issue 3, 1 March 1979, Pages 273–284

<https://academic.oup.com/aje/article/109/3/273/110012>

The results of the study pointed out that statistically the homes of kids with leukemia were more often close to powerlines. But the authors couldn't provide an explanation for the results and the study was quickly discredited due to

methodological errors. Nonetheless, a number of studies were conducted in the subsequent period, like this one from the UK.

#Residential distance at birth from overhead high-voltage powerlines: childhood cancer risk in Britain 1962–2008, 2014

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3950865/>

In this study we could find an increased risk in terms of figures in the 70ies and 80ies, but not in the 90ies and 2000s. Looking at the time frame as a whole, no increased risk was detected. So the scientists concluded that it is unlikely that high voltage power lines increase the the risk of leukaemia in children.

But the majority of studies couldn't confirm the findings of Wertheimer and Leeper.

#Electrical wiring configurations and childhood leukemia in Rhode Island, 1980

<https://www.ncbi.nlm.nih.gov/pubmed/7361752>

#The probability for misclassification in the Wertheimer-Leeper wiring configuration code, 1991

<https://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=24006371>

#Impact of high electromagnetic field levels on childhood leukemia incidence, 2012

<https://onlinelibrary.wiley.com/doi/full/10.1002/ijc.27542>

– This particular study was quickly discredited though: The connection could not be explained and no direct causal link was confirmed.

#Electromagnetic fields and cancer, National Cancer Institute, 2018

<https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet>

#Do High Voltage Power Lines Cause Cancer?, Forbes–Magazine, 2014

<https://www.forbes.com/sites/stevensalzberg/2014/09/01/do-high-voltage-power-lines-cause-cancer/#28dfcf136497>

– A lot of people who claim to be sensitive to the radiation coming from our appliances and cellphones.

#Electromagnetic fields and public health, WHO, 2005

<https://www.who.int/peh-emf/publications/facts/fs296/en/>

#Sensitivity to electricity--temporal changes in Austria, 2008

<https://www.ncbi.nlm.nih.gov/pubmed/18789137>

– People suffering from electromagnetic radiation report symptoms like headaches, nausea, skin reactions, burning eyes or exhaustion.

Electromagnetic hypersensitivity, WHO, 2005

<https://www.who.int/peh-emf/publications/facts/fs296/en/>

– A few studies have found much more unsettling results. Like possible connections between the side of the brain where frequent callers used their phone and the appearance of brain tumors.

One example for large-scale studies that found a connection between tumors and cell-phone use is the INTERPHONE-study. Over the course of the study more than 5,000 patients with brain tumors were frequently questioned about their cell phone use over the past four years. The object of research were two kinds of tumors: gliomas (tumors in the central nervous system of the brain) and meningiomas (mostly benign tumor in the membranous layers surrounding the central nervous system) – both of them are very rare types of cancer.

The result:

Average cell phone use did not increase the risk of cancer in patients. However, incidents of gliomas and meningiomas increased by 40% and by 15% in sick people with intense cell-phone use.

Oddly enough, for frequent cell phone uses the cancer risk was about 20% lower compared to the average cell phone user. The authors of the study attributed this result to statistical imprecision. But according to this logic the other findings of this study might suffer from statistical imprecision as well. So, it is unclear how accurate the study actually was.

#Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study, 2010

<https://academic.oup.com/ije/article/39/3/675/631387>

Press-Release of the WHO, Interphone study reports on mobile phone use and brain cancer risk, 2010

https://www.iarc.fr/wp-content/uploads/2018/07/pr200_E.pdf

#Critique of “Risk of Brain Tumors from Wireless Phone Use”, 2011

<https://sciencebasedmedicine.org/critique-of-risk-of-brain-tumors-from-wireless-phone-use/>

In a comparative study two years later an increased cancer risk through cell-phone radiation could not be proven.

#Mobile phone use and glioma risk: comparison of epidemiological study results with incidence trends in the United States, 2012

https://web.archive.org/web/20150217215254/http://www.izmf.de/sites/default/files/Gesundheit_British%20Medical%20Journal_Glioma%20Risk.pdf

– Many of the much-cited studies that spread panic about electromagnetic radiation are highly controversial: For example, a series of population studies based on surveys and self reporting.

The participants of the INTERPHONE-study were for example asked in detail about their cell phone use in the past years. Among other things, they were asked how often they talked to someone on the phone and how long these calls lasted. Another question was on which side of the head they put the phone and which kind of technology they were using.

However, the participants' powers of recall are not a sufficient basis for a scientific conclusion. This is why the scientists compared these subjective information with data about the duration of the calls provided by the network operators.

Critics still accused the study to be depending too much on the subjective memory of the participants.

Press-Release of the WHO, Interphone study reports on mobile phone use and brain cancer risk, 2010

https://www.iarc.fr/wp-content/uploads/2018/07/pr200_E.pdf

#Critique of "Risk of Brain Tumors from Wireless Phone Use", 2011

<https://sciencebasedmedicine.org/critique-of-risk-of-brain-tumors-from-wireless-phone-use/>

#Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study, EMF-Portal, 2010

<https://www.emf-portal.org/de/article/18215>

– Studies or media reports may be cherry picking the findings that best suit their opinion or make for the most exciting headline.

One report that was particularly criticized was the Bioinitiative-report of 2007. The second Bioinitiative-report of 2012 hardly took any of the criticism into account. In both of them, several hundred studies on electromagnetic radiation in connection to health risks were analysed and compiled. The main argument of the critics was that the report purposefully chose studies that concluded electromagnetic radiation was harmful. For example the authors left out several relevant studies that couldn't show any association. On the other hand many studies that observed an increased risk were included even though they were not peer-reviewed.

Bioinitiative 2012 – A Rationale for biologically-based exposure standards for low-intensity electromagnetic radiation, 2012

<http://www.bioinitiative.org/conclusions/>

<https://www.bioinitiative.org/table-of-contents/>

Luc Verschaeven, the renowned expert on non-ionizing radiation, evaluated the Bioinitiative-report. According to him, some of the report's conclusions were shortened too much and also exaggerated. Luc Verschaeven also criticised the composition of the team of authors. Some of the authors were not exactly scientists while others were affiliated with online shops selling products that supposed to protect from radiation.

You can have a look at the complete list of his evaluation online:

Evaluations of International Expert Group Reports on the Biological Effects of Radiofrequency Fields, 2012

http://cdn.intechopen.com/pdfs/31625/InTech-Evaluations_of_international_expert_group_reports_on_the_biological_effects_of_radiofrequency_fields.pdf

- *From the more than 30 expert group opinions that were published during the 2009-2011 period the vast majority did not consider that there is a demonstrated health risk from RF- exposure from mobile telephones and other wireless communication devices. Because of remaining uncertainties, especially with respect to long-term exposures, some caution is still expressed. This is the reason why IARC recently classified RF-electromagnetic fields as 2B- carcinogens (= possibly carcinogenic).*

This blogpost explains the weaknesses of the report in detail.

#Picking Cherries in Science: The Bio-Initiative Report. 2013

<https://sciencebasedmedicine.org/picking-cherries-in-science-the-bio-initiative-report/>

– For example a study looking for cancer in rats and mice from cell phone radiation. The results seemed to show a connection. But for some reason only in male rats. And none at all in mice.

In the NTP-study rats and mice were constantly exposed to electromagnetic fields which corresponded with the 2G and 3G mobile phone standards. 2G and 3G were the most common mobile phone networks at the time the study was conducted. By now 4G and LTE are more common.

#High Exposure to Radio Frequency Radiation Associated With Cancer in Male Rats, 2018

<https://www.niehs.nih.gov/news/newsroom/releases/2018/november1/index.cfm>

Rat study:

#NTP technical report on the toxicology and carcinogenesis studies in hsd:sprague dawley sd rats exposed to whole-body radio frequency radiation at a frequency (900 mhz) and modulations (gsm and cdma) used by cell phones, 2018

https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr595_508.pdf

Mouse study:

#NTP technical report on the toxicology and carcinogenesis studies in b6c3f1/n mice exposed to whole-body radio frequency radiation at a frequency (1,900 mhz) and modulations (gsm and cdma) used by cell phones, 2018

https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr596_508.pdf

The most important result of the NTP-study was that a high exposure to strong high frequency fields caused tumors in the heart tissue of male rats. There were several problems with the study though. The lowest radiation that was used matched the thresholds set by the European Union. These thresholds considerably exceeded the irradiance value emitted by most cell phones. So the animals were exposed to a significantly higher amount of radiation than we are in our everyday life.

Additionally there were some very odd and inexplicable results in the study. One example were statistics that showed that the rats that were exposed to radiation had a longer lifespan on average than their peers that didn't experience any radiation treatment.

#Why You Shouldn't Worry About the New Study Linking Cellphones to Cancer, 2018

<https://www.livescience.com/63996-cellphones-cancer-rats-ntp-study.html>

#Statement from Jeffrey Shuren, M.D., J.D., Director of the FDA's Center for Devices and Radiological Health on the National Toxicology Program's report on radiofrequency energy exposure, 2018

<https://www.fda.gov/news-events/press-announcements/statement-jeffrey-shuren-md-jd-director-fdas-center-devices-and-radiological-health-national>

– The classification „possibly carcinogenic“ actually means that there are some hints that it might cause cancer but we can't prove it and that we will keep an eye out.

The WHO investigates agents that might potentially cause cancer and classifies them into five different groups. But the WHO itself stresses that its research is only about the question whether or not a certain substance causes cancer, but not to what extent.

Group 1 = Carcinogenic to humans (plutonium, asbestos or smoking)

Group 2A = Probably carcinogenic to humans (red meat, acrylamide, open chimneys)

Group 2B = Possibly carcinogenic to humans (electromagnetic radiation, chloroform, lead)

Group 3 = Not classifiable as to its carcinogenicity to humans (caffeine, tea)

Group 4 = Probably not carcinogenic to humans (caprolactam)

#List of Classifications, WHO

<https://monographs.iarc.fr/list-of-classifications-volumes/>

Wikipedia offers a faster overview:

#Wikipedia-article on carcinogen, Classification

<https://en.wikipedia.org/wiki/Carcinogen>

So electromagnetic radiation is now one category below red meat and open chimneys. In general, the WHO almost never completely excludes an agent. Even group 4 isn't called "not carcinogenic to humans", but "probably not carcinogenic to humans" and lists only one single agent: caprolactam, a starting material for certain synthetics. For the rest there is no single substance listed as "probably not carcinogenic to humans".

As there is still no clear evidence that electromagnetic radiation is completely harmless the WHO classified it as "possibly carcinogenic". But this classification is no reason to panic.

#Non-ionizing radiation, part 2: radiofrequency electromagnetic fields, 2011

<https://monographs.iarc.fr/wp-content/uploads/2018/06/mono102.pdf>

- *It found "limited evidence" in humans for the carcinogenicity of ELF magnetic fields in relation to childhood leukemia, with "inadequate evidence" in relation to all other cancers. It found "inadequate evidence" for the carcinogenicity of ELF magnetic fields based on studies in lab animals.*
- *It found "inadequate evidence" for the carcinogenicity of ELF electric fields in humans.*

#Classification of high frequency electromagnetic fields by the IARC, retrieved, 2019

https://www.bfs.de/EN/topics/emf/hff/effect/iarc/iarc.html;jsessionid=E0B6E2020FB023DA0E976A307F6EF6BC.2_cid365

– On the whole there was no consistent evidence in human studies that electromagnetic radiation below exposure value limits causes health problems.

#International and National Expert Group Evaluations: Biological/Health Effects of Radiofrequency Fields, 2014

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4199025/>

There are thresholds for the amount of electromagnetic radiation that humans are exposed to in their everyday lives. They are supposed to protect us from scientifically proven effects, such as the tingly feeling on your skin.

However there are different categories for different kinds of electromagnetic fields. And those are in turn indicated in different units. Different thresholds are applied for low-frequency fields, high-frequency fields and static fields.

Overview on ELF EMF throughout the world:

#Limits in the rest of the world, retrieved 2019

<http://www.emfs.info/limits/world/>

For mobile devices no thresholds are set, but instead they have to meet product standards. These standards are determined not by measuring the power of the emitted electromagnetic field, but by how much radiation is absorbed by our bodies. This is called the SAR value (short for specific absorption rate). In Germany for example, a cell phone must not surpass a SAR value of 2 Watts per kilogram.

Most cell phones show a SAR value of around 1 watt per kilogram if you put them next to your ear. But this value declines very fast with every centimetre you hold the phone away from your head.

Here you find a list of phones radiating the most...:

#The Phones Emitting the Most Radiation, 2019

<https://www.statista.com/chart/12797/the-phones-emitting-the-most-radiation/>

...and the least:

#The Phones Emitting the Least Radiation, 2019

<https://www.statista.com/chart/12841/the-phones-emitting-the-least-radiation/>

The thresholds are not the same in every country. Most of them refer to the recommendations of the ICNIRP (International Commission on Non-Ionizing Radiation Protection), or in the case of Europe, to the recommendations of the EU council. But still there are significant differences. In Great Britain for example, the limit for low-frequency electric fields is twice as high as the limit in Germany and the british limits for magnetic fields is even tripled.

#Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)

<http://www.icnirp.org/cms/upload/publications/ICNIRPemfgdlger.pdf>

#1999/519/EC: Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31999H0519>

And here a comparison with other European countries.

#Comparison of European policies of low frequency (power frequency for high-

voltage power lines) electric and magnetic fields, retrieved 2019

http://www.bfs.de/EN/topics/emf/expansion-grid/protection/limit-values-europe/limit-values-europe_node.html

And here an overview of how strong the radiation coming from different devices is.

#Overview of the sources of high-frequency fields, retrieved 2019

<https://www.bfs.de/EN/topics/emf/hff/sources/overview/overview.html>

– There are some statistical associations, but they are mostly weak and inconsistent.

Statistical correlations could be established in the NTP-study for example. Male rats showed brain tumors after an intensive exposure. Since this wasn't the case in female rats and mice, the findings were considered rather weak. Moreover, the results were inconsistent, as most of the follow-up studies couldn't replicate them.

#High Exposure to Radio Frequency Radiation Associated With Cancer in Male Rats, 2018

<https://www.niehs.nih.gov/news/newsroom/releases/2018/november1/index.cfm>

Another example for weak statistical connections is the study of 1979, claiming leukaemia in children was associated with high-voltage lines.

#Electrical wiring configurations and childhood cancer, in American Journal of Epidemiology, Volume 109, Issue 3, 1 March 1979, Pages 273–284,

<https://academic.oup.com/aje/article/109/3/273/110012>

Granted that the results of those studies were proven (which, careful, is NOT the case!), they still need to be put into context.

On average 60 children get leukaemia in Switzerland each year. The Swiss agency for environment calculated that high-voltage lines could explain one single additional case per year at most. The other 59 cases must have other causes. If high-voltage power lines would really cause leukaemia in children they would still be responsible for less than 2% of all cases – and this, again, is far from proven.

#Gesundheitliche Auswirkungen von niederfrequenter Strahlung, 2018

<https://www.bafu.admin.ch/bafu/de/home/themen/elektrosmog/fachinformationen/auswirkungen-elektrosmog/gesundheitliche-auswirkungen-von-niederfrequenter-strahlung.html>

English version:

#Low-frequency magnetic fields and cancer (Summary), 2009

<https://www.bafu.admin.ch/bafu/en/home/topics/electrosmog/publications-studies/publications/low-frequency-magnetic-fields-and-cancer.html>

A good overview over the statistical connections and further explanations are offered by the responsible state authorities . For example:

US: EPA

#Radiation Resources Outside of EPA, retrieved 2019

<https://www.epa.gov/radiation/radiation-resources-outside-epa>

GB: department for public health:

#Electromagnetic fields, 2013

<https://www.gov.uk/government/collections/electromagnetic-fields>

#Scientifically discussed biological and health effects of high frequency fields, 2019

<http://www.bfs.de/EN/topics/emf/hff/effect/hff-discussed/hff-discussed.html>

The WHO gathered the most important results:

#WHO: What are electromagnetic fields?, retrieved 2019

<https://www.who.int/peh-emf/about/WhatisEMF/en/index2.html>

#Cancer and childhood leukemia, EMF–Portal, retrieved 2019

<https://www.emf-portal.org/en/cms/page/home/effects/low-frequency/cancer-and-childhood-leukemia>

- *However, the evidence of epidemiological studies is limited due to methodical problems such as selection bias (c.f. background information on study types). Moreover, no underlying mechanism of action has been found to date, which could explain the development of leukemia due to weak magnetic fields. The results of these epidemiological studies could not be verified by animal studies, either (WHO 2007).*

#Cancer, EMF–Portal, retrieved 2019

<https://www.emf-portal.org/en/cms/page/home/effects/radio-frequency/cancer>

– Research showed they could be experiencing the so called nocebo effect.

The nocebo-effect describes the phenomenon that someone feels real symptoms only because the person believes something might be harmful.

#Symptom Presentation in Idiopathic Environmental Intolerance With Attribution to Electromagnetic Fields: Evidence for a Nocebo Effect Based on Data Re-Analyzed From Two Previous Provocation Studies 2018

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6121031/>

- *“Interestingly, control participants also reported experiencing more symptoms and greater symptom severity when they too believed the base station was “on” compared to “off”. Thus, a nocebo effect provides a reasonable explanation for the presence of symptoms in IEI-EMF and control participants.”*

In the study above, electrosensitive people were exposed to electromagnetic radiation from a base station while blindfolded. Sometimes they were told that they were exposed to radiation and other times they were not, even though in both cases the base station was switched on. The participants felt significantly stronger symptoms when they thought the base station was switched on. Even participants who didn't claim to be electrosensitive gave different statements on their subjective conditions, depending on whether or not they thought the station was switched on. The authors of the study considered the nocebo-effect a logical explanation.

#Are some people sensitive to mobile phone signals? Within participants double blind randomised provocation study, 2006

<https://www.bmj.com/content/332/7546/886.full>

#Electrosensitivity: Review of Relevant Research, 2017

<https://mdsafetech.org/problems/electro-sensitivity/electrosensitivity-overview-of-relevant-research/>

- *Rubin and colleagues published two reviews of EHS provocation studies, evaluating 31 experiments in 2005 and 15 new studies in 2010. (23, 24) In the 2005 article, Rubin concluded: “The symptoms described by ‘electromagnetic hypersensitivity’ sufferers can be severe and sometimes disabling. However, it has proved difficult to show under blind conditions that exposure to EMF can trigger these symptoms.” Their 2010 study reached a similar conclusion.*

This meta-analysis assessed 31 experiments, in which electrosensitive people were exposed to radiation blindfolded and they concluded that the symptoms occurred independently to the radiation.

#Conclusions on electromagnetic fields, European Commission

http://ec.europa.eu/health/scientific_committees/opinions_layman/en/electromagnetic-fields/index.htm#10

Electromagnetic hypersensitivity: a systematic review of provocation studies, 2005

<https://www.ncbi.nlm.nih.gov/pubmed/15784787>

– So far we have no robust evidence that electricity below security limits has any negative effect on humans.

In almost all countries the responsible health agencies released statements regarding the topic. We picked a selection of international institutions for you:

#Electric & Magnetic Fields, NIH, 2018

<https://www.niehs.nih.gov/health/topics/agents/emf/index.cfm>

#Final Opinion on EMF, EU

https://ec.europa.eu/health/scientific_committees/consultations/public_consultations/scenihf_consultation_19_en

#Scientifically discussed biological and health effects of high frequency field, 2019

<http://www.bfs.de/EN/topics/emf/hff/effect/hff-discussed/hff-discussed.html>

#WHO: What are electromagnetic fields?, retrieved 2019

<https://www.who.int/peh-emf/about/WhatisEMF/en/index2.html>

– Outdoor air pollution is linked to 4.2 million premature deaths globally each year.

Ambient air pollution: Health impacts, 2018

<https://www.who.int/airpollution/ambient/health-impacts/en/>

– Several long-term studies are already ongoing.

#MOBI_KIDS Study

<https://cordis.europa.eu/project/rcn/89894/reporting/en>

#COSMOS Study

<http://www.thecosmosproject.org>

Further Reading:

The EMF-Portal of the University Aachen RWTH provides the most extensive collection of studies on electromagnetic radiation

<https://www.emf-portal.org/en>

– On the Interpretation of epidemiological studies

This website explains very well what's important regarding the interpretation of studies on electromagnetic fields.

#How to Interpret Scientific Findings In the Cell Phone Radiation Controversy, 2018

<https://pongcase.com/blog/interpret-scientific-findings-cell-phone-radiation-controversy/>

#WHO: What are electromagnetic fields?, retrieved 2019

<https://www.who.int/peh-emf/about/WhatisEMF/en/index2.html>