The EMF Research Book (draft edition)

A collection of theories and hyptheses for the study of biological and health effects of electromagnetic fields

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Preface

> Tip
>
> *The best book for scientific ideas, including generating new ideas and bringing ideas to life – within the field of biological and health effects of electromagnetic fields (EMF).*

This is a collection of theories and hypotheses related to the study of biological and health effects of non-ionizing radiation.

The book is an open science project started in 2024 and is work in progress. A final edition may take years to complete. Scientists and authors familiar with the topic can contribute and will be credited for any contribution. If you want to contribute, you can simply submit additions and revisions at the book's GitHub repository. Currently, I serve as the editor, but that may be changed if more experienced authors decide to contribute.

 Potentially, additional paperback, hard copy or e-book editions can be made available for sale at a future point in time.

The aim of the book is to be a comprehensive list of the theories and hypotheses related to non-ionizing radiation that can be used for researchers and others who want to familiar themselves with the topic; look up potential frameworks to interpret findings; or explore research gaps and possible new research questions and methods.

The aim is not to discuss specific research findings, but rather to provide a scope of theories. However, relevant scientific references for each theory should be included. But to support the progress of the development of this book, such lists may most often not be exhaustive, meaning that a theory may be included with one reference initially that is not necessarily the most updated and correct reference.

It is also not the aim that theories or hypotheses included should have been proven to be correct (or scientifically speaking, not haven been falsified). Theories that are speculative, or even wrong, may also be included, and the reader should be aware this. The reason for this is that ideas that have not yet been researched may have extra value in that they may point to research gaps, and theories that have proven wrong may prohibit other researchers to waste their efforst following that same path.

1 Introduction (draft)

Electromagnetic fields are ...

Part I

Characteristics (draft)

This chapter ...

2 Characteristics of electromagnetic fields and radiation

2.1

2.2 Natural electromagnetism

2.2.1 Space and the sun

Coronal mass ejection (CME): Ejection of plasma mass from the sun. One often talks about flares, and flares of different strength, e.g. X1 to X100. The Carrington event (1859) is said to have been between X45 or X80 flare (ADD REFERENCE). One also talk about the KP-index – the geomagnetic storm index, with values like typically Kp5-Kp9.

Cosmic microwave background radiation (CMB(R)): (LOOK UP AND IMPROVE TERMINOLOGY AND ABREVIATION, NOT SURE IF THIS IS USED OR COMMONLY USED)

3 Nomenclature (draft)

Part II

Effects (draft)

4 Thermal theories (draft)

5 Non-thermal theories (draft)

5.1 The interaction with specific biological components

5.1.1 Melanin

5.2 The Zeeman effect (Chiabrera et al. 2000)

5.3 The Rouleaux Effect

5.4 Microbiome

A hypothesis about how the microbiome can be affected by exposure to anthropogenic electromagnetic fields and create health effects, may first have been presented in a conference abstract in 2022, for a conference in Sogn og Fjordane in Norway (Manzetti 2022)

6 Ionizing radiation theories (draft)

7 Specific diseases (draft)

7.1 Cardiovascular disease

7.1.1 Blood pressure

Cell phone calls, and thus radiofrequency radiation, may be related to the development of high *blood-pressure* (hypertension) , according to a large study using data from the UK Biobank (Ye et al. 2023). Radiation exposure can be assumed to be strongly affected by cell phone usage. Confounding factors and other explanatory models can always exist. Mecanistic models for how a blood pressure increase can happen due to radiofrequency radiation, is a topic for future studies, – and such studies will increase the confidence in the findings from epidemiological studies on cell phone usage or similar exposure, and blood pressure.

7.2 Cancer

One of the earliest finding of cancer (malignant tumors) fom RF exposure was found in rats in 1984 (Microwave News 1984) The finding came after exposure to low level pulsed 2450 MHz radiation, in the first long-term study on microwave exposure in the United States, funded by the U.S. Air Force in a $5 million (1984 value) dollar study. Notably, it took eight years from the findings were first presented at a conference until they were published in a scientific journal (Microwave News 1993; Chou et al. 1992).

8 Psychological theories (draft)

Part III

Exposure assessment

...

9 Real world measurements (draft)

9.1 5G exposure

2022:

- Columbia, SC, USA (Koppel and Hardell 2022)

2024:

- Stockholm, Sweden, 2024 (Hardell and Koppel 2024)

10 Exposure in general (draft)

10.1 Fifth generation mobile phone technology (5G)

Non-user exposure:

A 2023 study performed measurements "near two 5G New Radio (NR) base stations, one with an Advanced Antenna System (AAS) capable of **beamforming** and the other a traditional microcell." (emphasizment/bold part added)(Aerts et al. 2023).

They found that exposure was in general lower for non-users than for users, but that "for the non-user, the difference lies in whether they are in a beam or not" and that when there are many users around the base station exposure can generally increase for the non-user.

Part IV

Resources (draft)

In this part of the book, various resources that can aid in research on electromagnetic fields. The various chapters holds resources such as information on literature databases, open data and scientific communities around the world.

Idenifying research gaps

If you are interested in conducting new research on EMFs, the table below with *the seven research gaps* from Miles (2017) may aid you. What research gap *type* do you find to be the most important within EMF science?

Research Gap Type	Definition
Evidence Gap (Contradictory Evidence Gap)	Results from studies allow for conclusions in their own right, but are contradictory when examined from a more abstract point of view [Jacobs, 2011; Müller-Bloch & Kranz, 2014; Miles, 2017].
Knowledge Gap (Knowledge Void Gap)	Desired research findings do not exist [Jacobs, 2011; Müller-Bloch & Kranz, 2014; Miles, 2017].
Practical-Knowledge Gap (Action-Knowledge Conflict Gap)	Professional behavior or practices deviate from research findings or are not covered by research [Jacobs, 2011; Müller-Bloch & Kranz, 2014; Miles, 2017].
Methodological Gap (Method and Research Design Gap)	A variation of research methods is necessary to generate new insights or to avoid distorted findings [Jacobs, 2011; Müller-Bloch & Kranz, 2014; Miles, 2017].
Empirical Gap (Evaluation Void Gap)	Research findings or propositions need to be evaluated or empirically verified [Jacobs, 2011; Müller-Bloch & Kranz, 2014; Miles, 2017].
Theoretical Gap (Theory Application Void Gap)	Theory should be applied to certain research issues to generate new insights. There is lack of theory thus a gap exists [Müller-Bloch & Kranz, 2014; Jacobs, 2011; Müller-Bloch & Kranz, 2014; Miles, 2017].
Population Gap	Research regarding the population that is not adequately represented or under-researched in the evidence base of prior research (e.g., gender, race/ethnicity, age, etc.) [Robinson, et al, 2011].
Sources	Robinson, Saldanhea, & McKoy (2011); Müller-Bloch & Kranz, (2015); Miles, (2017).

11 Literature data (draft)

11.1 Soviet research

In the earliest time of EMF science, much research was done in the Soviet Union.

Big portions of this body of research may not be available in literature databases. As a starting point of an exploration of the Soviet research, below is a list of some sources discussing this literature.

- Glaser and Dodge (1976)
- D. I. McRee (1979)
- Donald I. McRee (1980)
- Kositsky, Nizhelska, and Ponezha (2001)
- Kostoff (2019)
- Kostoff (2020)

11.2 Short notes about general databases for scientific literature

11.2.1 Biomedical and health literature databases

11.2.1.1 Pubmed/MEDLINE

- "PubMed is a more user-friendly search engine for MEDLNE" (my translation of snl.no article.
- "MEDLINE is the largest and oldest biomedical database in the world" ("MEDLINE Data" n.d.).
- PubMed makes content searchable from three databases MEDLINE, PubMed Central and Bookshelf, and MEDLINE is the main component of PubMed:

  > To be added to a database, a publication must apply and be selected by NLM for inclusion in MEDLINE, PMC, or Bookshelf. PubMed indexes and makes searchable the contents of these databases; MEDLINE is the primary component of PubMed.
  >
  > — About PMC

11.2.1.2 Embase (by Elsevier)(paid-access)

Embase has a similar scope to PubMed/MEDLINE - a database for biomedical research literature.

Embase claims to contain 99% of journals in MEDLINE, plus 3000 more journals that are not indexed by PubMed. It is stronger on drug literature than MEDLINE. It is also supposed to be better at capturing conference abstracts.

See also the about page at Embase.

11.2.1.3 Cochrane Reviews database

What is a Cochrane review?

> A Cochrane Review is a systematic review of research in health care and health policy that is published in the Cochrane Database of Systematic Reviews."
>
> — About Cochrane Reviews

A total of 9211 Cochrane Reviews had been published as of March 2024.

11.2.1.4 SveMed+

SweMed has better coverage for Scandinavian literature (from) (AI translation):

> SveMed+ is a bibliographic database that contains references to articles from Scandinavian journals in the fields of medicine, dentistry, healthcare, occupational therapy, nursing, and physiotherapy.

11.2.1.5 Epistemonikos

About Epistemonikos from the Norwegian site *Helsebiblioteket* (AI translation):

> Epistemonikos is a free international (multilingual) database that contains systematic reviews on clinical questions. Epistemonikos systematically searches PubMed and other databases for relevant systematic reviews and overviews of reviews on treatment, diagnosis, prognosis, harm, and etiology.

From the quote, it seems to focus on clinical questions, i.e. *treatment of disease*. Although etiology is also mentioned, so the database may provide useful in some instances for health related questions outside treatment of disease.

11.2.1.6 CINAHL (by EBSCO) (paid-access)

The CINAHL database focuses on nursing, allied health, and healthcare literature:

> CINAHL indexes the top nursing and allied health literature available including nursing journals and publications from the National League for Nursing and the American Nurses Association.

It includes:

> 3,630 active indexed and abstracted journals 3,320 active peer-reviewed indexed and abstracted journals

11.2.1.7 Global Health (by EBSCO) (paid-access)

The *Global Health* database focuses on global health issues:

> Global Health is the only specialized bibliographic, abstracting and indexing database dedicated to public health, completing the picture of international medical and health research by capturing key literature that is not covered by other databases, providing users with a truly global perspective.

It inludes (as of March, 2025):

- 4,500,000 scientific records from 1973 to the present day
- 185,000 records added each year
- 7,000 indexed serials, books, book chapters, reports, conference proceedings, patents, theses, electronic publications and other hard-to-find resources
- 4,480 journals, of which more than 3,600 are unique to Global Health

11.2.1.8 AMED (paid-access)

AMED stands for (Allied and Complementary Medicine).

About AMED from the Norwegian page *Helsebiblioteket* (AI translated):

> AMED (Allied and Complementary Medicine) registers journal articles in alternative medicine, physiotherapy, occupational therapy, palliative care, speech therapy, and rehabilitation. It covers nearly 600 journals, many of which are not found in other databases.

11.2.1.9 OVID (paid-access): Search several databases

OVID allows you to search though multiple databases

- MEDLINE, EMBASE, PsychInfo, HaPI, AMED, Maternity and Infant Care, Global Health and ERIC (an education-related research database)
- Clinical reference sources: BMJ Best Practices, UpToDate

11.2.1.10 AI tools for literature reviews

A lot of journals (but not all) submit publications to Semantic Scholar.

The following two tools use Semantic scholar as their primary data source:

- Elicit.com (148 million scientific papers): Good for systematic reviews and meta-analyses.

- Consesus.app (>220 million scientific papers): Summaries of "scientific consensus" on any question or research question.

Semantic Scholar is great for for instance finding academic papers and citation analysis. At semanticscholar.org, they say that Semantic Scholar is a "free, AI-powered research tool for scientific literature".

11.2.2 Multidisciplinary databases

11.2.2.1 Web of Science (by Clarivate) (paid-access)

Some main features are listed below. For more information see Web of Science website.

Web of Science Core Collection:

– Number of journals: "> 22,171 journals + books and conference proceedings"

– Coverage: Over 91 million records; More than 143,000 books; Over 304,000 conferences.

– Content: "Life sciences, biomedical sciences, engineering, social sciences, arts & humanities. Strongest coverage of natural sciences, health sciences, engineering, computer science, materials sciences."

Web of Science platform

– Number of journals: "> 34,651 journals + books, proceedings, patents, and data sets"

– Coverage: Over 217 million records (journals, books, and proceedings);59 million patent families (> 115 million patents); More than 13 million data sets

– Content: “Biomedical sciences, natural sciences, engineering, social sciences, arts & humanities. Strongest coverage of natural sciences & engineering, computer science, materials sciences, patents, data sets. Regional Citation indexes provide deep coverage in sciences, social sciences, and humanities for Korea, Russia (suspended as of March 2022), Latin America, and China.”

11.2.2.2 Scopus (by Elsevier)

What is Scopus (from Wikipedia):

> Scopus is Elsevier’s abstract and citation database launched in 2004.[1] Scopus covers 36,377 titles (22,794 active titles and 13,583 inactive titles) from 11,678 publishers, of which 34,346 are peer-reviewed journals in top-level subject fields: life sciences, social sciences, physical sciences and health sciences. It covers three types of sources: book series, journals, and trade journals. Scopus also allows patent searches in a dedicated patent database Lexis-Nexis, albeit with a limited functionality.[2]

11.2.3 Technical disciplines literature databases

11.2.3.1 IEEE Xplore:

IEEE Xplore lists 6,266,140 items as of April 1 2024.

This can be an important additional source for literature related to electromagnetic fields, as it relates to health, even if articles will be more on the technical side, than about health per se.

If you for instance search “James Benford” you will see a few example for articles that are not found in PubMed.

A quick search for “Microwave health” returned 2114 items on April 1 2024, and may give some indication on the number of studies to expect to find of more direct relevance for health in IEEE Xplore.

11.2.4 Psychology or social sciences literature databases

11.2.4.1 PsychINFO (by APA)

PsychINFO by APA is a database for literature within the discipline of psychology:

> The premier abstracting and indexing database covering the behavioral and social sciences from the authority in psychology.

APA PsycInfo at a glance • Over 5,000,000 peer-reviewed records • 144 million cited references • Spanning 600 years of content • Updated twice-weekly • Research in 30 languages from 50 countries • Records from 2,400 journals • Content from journal articles, book chapters, and dissertations • AI and machine learning-powered research assistance

11.2.5 Databases that possibly capture literature in languages other than English

11.2.5.1 LILACS

> The most important index of the technical-scientific literature in Latin America and the Caribbean, LILACS, was created in 1985 to record scientific and technical production in health. It has been maintained and updated by a network of more than 600 institutions of education, government, and health research and coordinated by Latin America and Caribbean Center on Health Sciences Information (BIREME), Pan American Health Organization (PAHO), and World Health Organization (WHO).
>
> LILACS contains scientific and technical literature from over 908 journals from 26 countries in Latin America and the Caribbean, with free access. About 900,000 records from articles with peer review, theses and dissertations, government documents, conference proceedings, and books; more than 480,000 of them are available with the full-text link in open access.
>
> The LILACS Methodology is a set of standards, manuals, guides, and applications in continuous development, intended for the collection, selection, description, indexing of documents, and generation of databases. This centralised methodology enables the cooperation between Latin American and Caribbean countries to create local and national databases, all feeding into the LILACS database. Currently, the databases LILACS, BBO, BDENF, MEDCARIB, and national databases of the countries of Latin America are part of the LILACS System.
>
> Health Sciences Descriptors (DeCS) is the multilingual and structured vocabulary created by BIREME to serve as a unique language in indexing articles from scientific journals, books, congress proceedings, technical reports, and other types of materials, and also for searching and retrieving subjects from scientific literature from information sources available on the Virtual Health Library (VHL) such as LILACS, MEDLINE, and others. It was developed from the MeSH with the purpose of permitting the use of common terminology for searching in multiple languages, and providing a consistent and unique environment for the retrieval of information. DeCS vocabulary is dynamic and totals 34,118 descriptors and qualifiers, of which 29,716 come from MeSH, and 4,402 are exclusive.

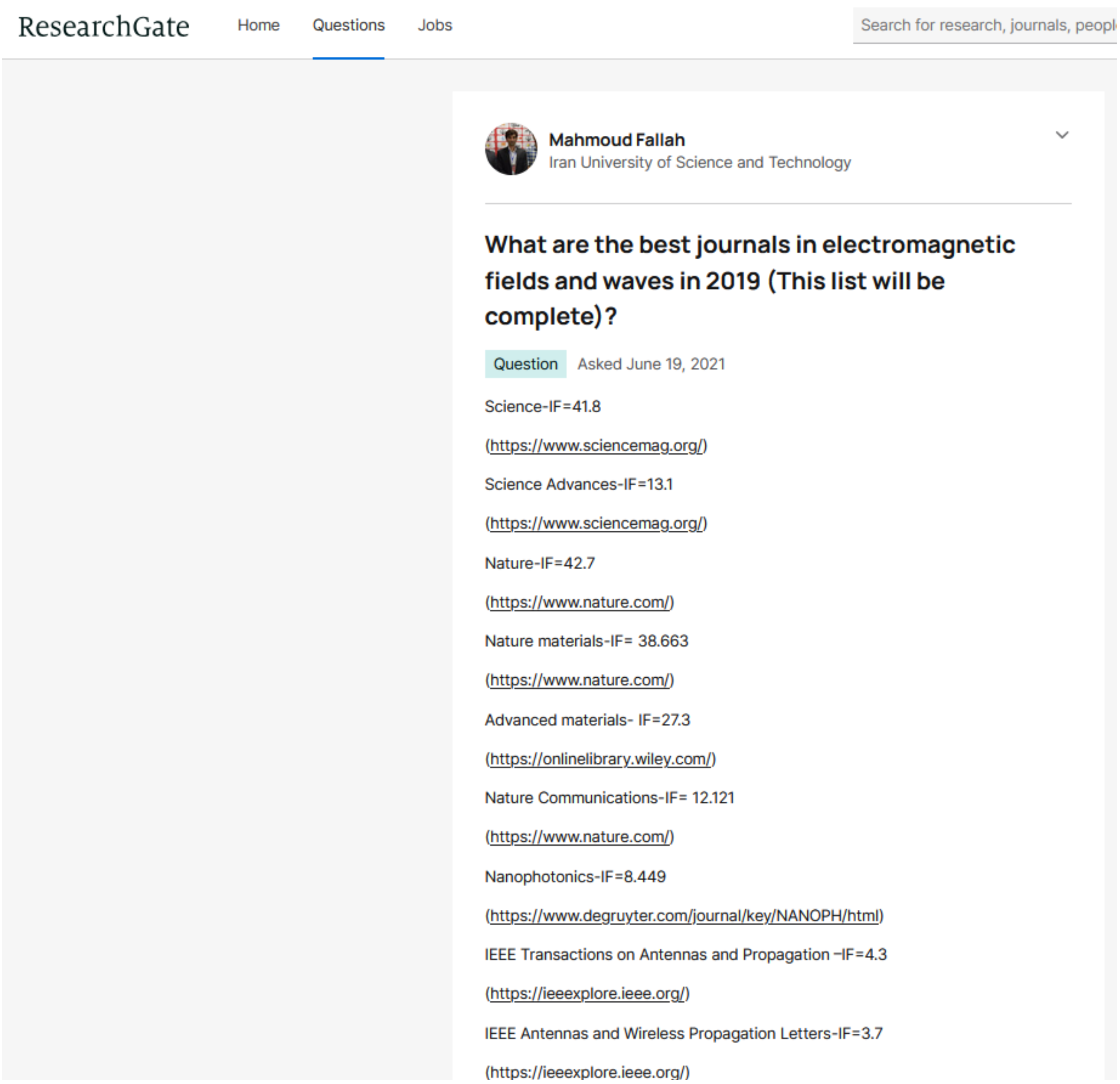
The quote is from this link.

11.3 Finding a journal to publish in

11.3.1 Impact factor

When choosing an journal, the *impact factor* may be useful to factor in to your decision.

Some lists of impact factors for potential journals may exit. For instance a researcher listed *"the best journals in electromagnetic fields and waves in 2019"*, at ResearchGate in June, 2021:


ResearchGate Home Questions Jobs

Search for research, journals, peopl

Mahmoud Fallah
Iran University of Science and Technology

What are the best journals in electromagnetic fields and waves in 2019 (This list will be complete)?

Question Asked June 19, 2021

Science-IF=41.8

(https://www.sciencemag.org/)

Science Advances-IF=13.1

(https://www.sciencemag.org/)

Nature-IF=42.7

(https://www.nature.com/)

Nature materials-IF= 38.663

(https://www.nature.com/)

Advanced materials- IF=27.3

(https://onlinelibrary.wiley.com/)

Nature Communications-IF= 12.121

(https://www.nature.com/)

Nanophotonics-IF=8.449

(https://www.degruyter.com/journal/key/NANOPH/html)

IEEE Transactions on Antennas and Propagation –IF=4.3

(https://ieeexplore.ieee.org/)

IEEE Antennas and Wireless Propagation Letters-IF=3.7

(https://ieeexplore.ieee.org/)

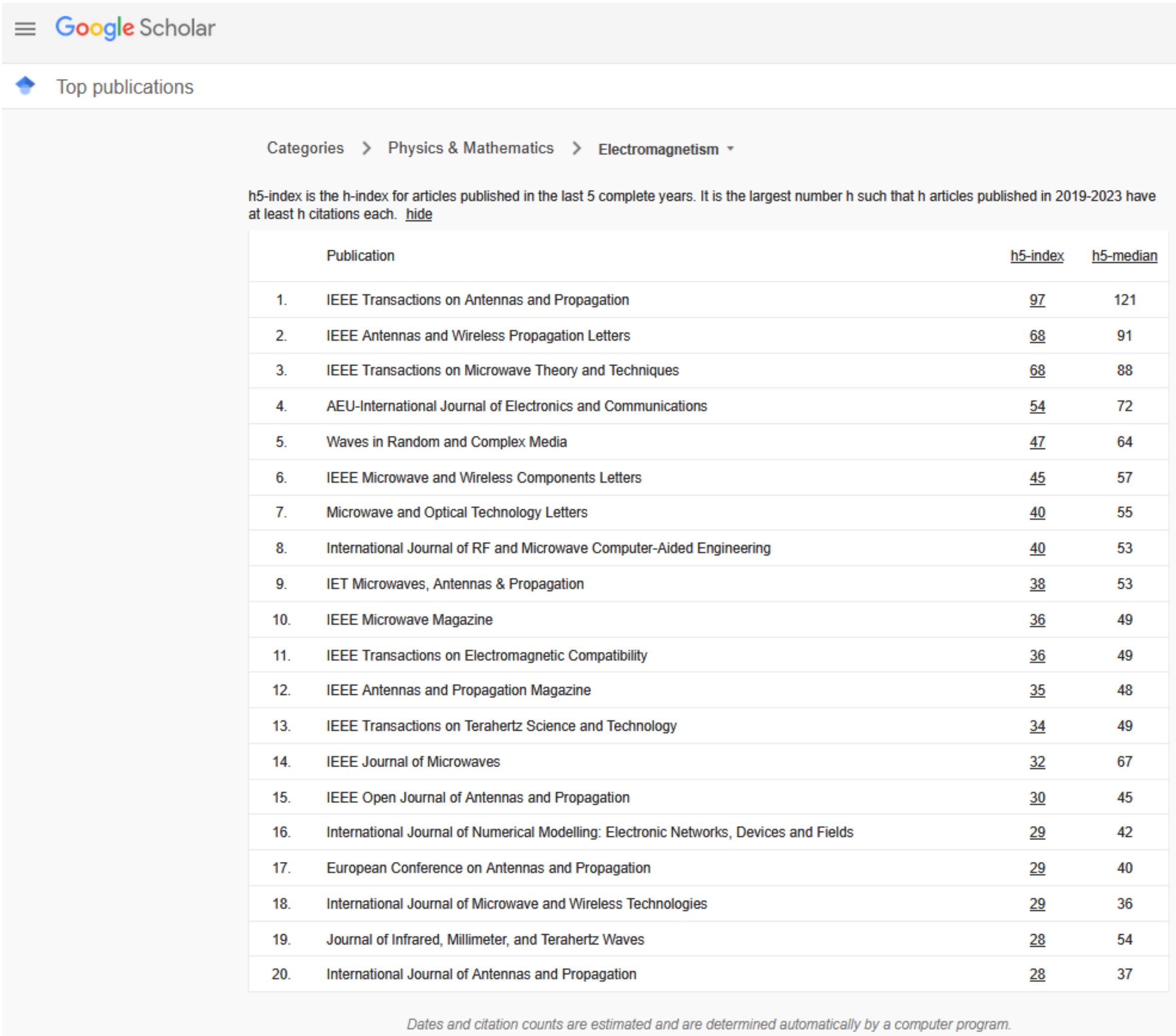
Note that impact factors may vary overtime. For instance the for the journal *Frontiers in Public Health*, which has an own section for the speciality of *Radiation and Health*, the impact factor was 3.709, then 6.461 in 2022. The journals usually list their impact factor at their website (the impact factor was 3.0 for *Frontiers in Public Health* in March 2025).

11.3.2 h-index

Another indicator to look at is the h-index, which is *the largest number h such that h articles published [for a given period] have at least h citations each.*

A list at Google Scholarlists the h5-index for the top publications within the category *Physics & Medicine/Electromagnetism.* A screenshot of the list from 30 March 2025 is shown below.

None of the lists mentioned above may however not be the most relevant for publications specifially related to *health* and EMFs.



Google Scholar

Top publications

Categories > Physics & Mathematics > Electromagnetism

h5-index is the h-index for articles published in the last 5 complete years. It is the largest number h such that h articles published in 2019-2023 have at least h citations each. hide

	Publication	h5-index	h5-median
1.	IEEE Transactions on Antennas and Propagation	97	121
2.	IEEE Antennas and Wireless Propagation Letters	68	91
3.	IEEE Transactions on Microwave Theory and Techniques	68	88
4.	AEU-International Journal of Electronics and Communications	54	72
5.	Waves in Random and Complex Media	47	64
6.	IEEE Microwave and Wireless Components Letters	45	57
7.	Microwave and Optical Technology Letters	40	55
8.	International Journal of RF and Microwave Computer-Aided Engineering	40	53
9.	IET Microwaves, Antennas & Propagation	38	53
10.	IEEE Microwave Magazine	36	49
11.	IEEE Transactions on Electromagnetic Compatibility	36	49
12.	IEEE Antennas and Propagation Magazine	35	48
13.	IEEE Transactions on Terahertz Science and Technology	34	49
14.	IEEE Journal of Microwaves	32	67
15.	IEEE Open Journal of Antennas and Propagation	30	45
16.	International Journal of Numerical Modelling: Electronic Networks, Devices and Fields	29	42
17.	European Conference on Antennas and Propagation	29	40
18.	International Journal of Microwave and Wireless Technologies	29	36
19.	Journal of Infrared, Millimeter, and Terahertz Waves	28	54
20.	International Journal of Antennas and Propagation	28	37

Dates and citation counts are estimated and are determined automatically by a computer program.

11.3.3 Scimago Journal & Country Rank

At Scimago Journal & Country Rank you can inspect different metrics of journal indicating the quality of the research in it.

12 Open data (draft)

13 EMF research around the world (draft edition)

14 Hypotheses(draft)

14.1 List of novel hypotesises or research questions

- Can RF radiation increase strength of risk from UV light exposure?

14.2 Long leaps and speculations

Here are some speculative theories or ideas. The ideas are only sicentific in so far that they are possible to test and disprove (falsify). They might be stimulating, engaging or just fun or provocative to read.

1) Today, all have their own phones. Particularly with the introduction of the fifth generation of mobile technlogy (5G) and beamforming, being close to others can increase exposure.
   If it is so that RF-EMF is a stressor, a question becomes, can there be *subliminal conditioning* (*pavlovian*), where the body experience stress when close to others, and thus starts to associate being close to others as stressful.
   How can such a theory be tested? Rats can be mounted with their own mini "mobile phone" with beamforming technology in a rat city with transmission antennas around the "city". Control groups do not have their own phone. Will the rats become less social?

15 Terms to use (draft)

Many phenomena within this research field have av diverse nomencalature.

In this chapter we list various terms with examples on usage.

- *electromagnetic radiation*

  electromagnetic radiation emitted by wireless communication devices

  From (Leszczynski 2025)

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