



# **The evidence base for risks from radiation**

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# Radiation

## What are the risks?



## Ionising Radiation

There is an acute risk at high doses.  
At low doses there is a risk of cancer in later life.

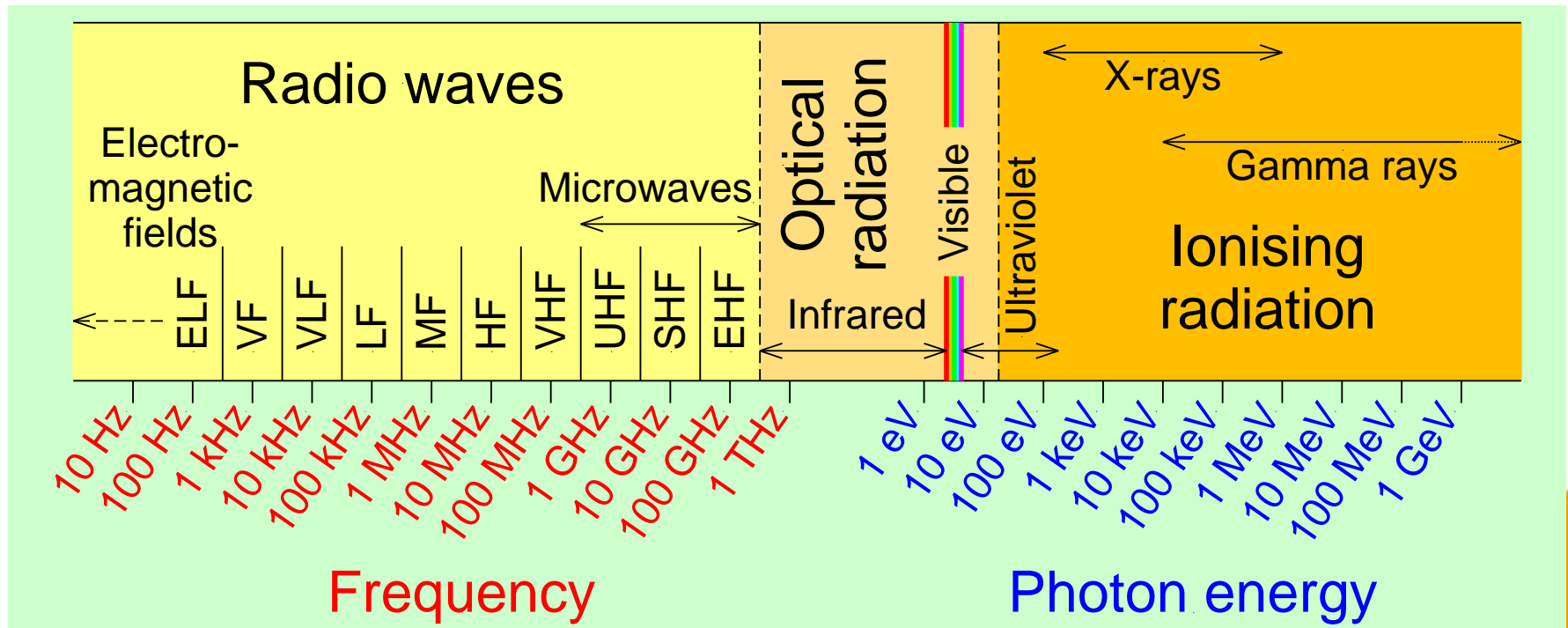


## Non-ionising radiation

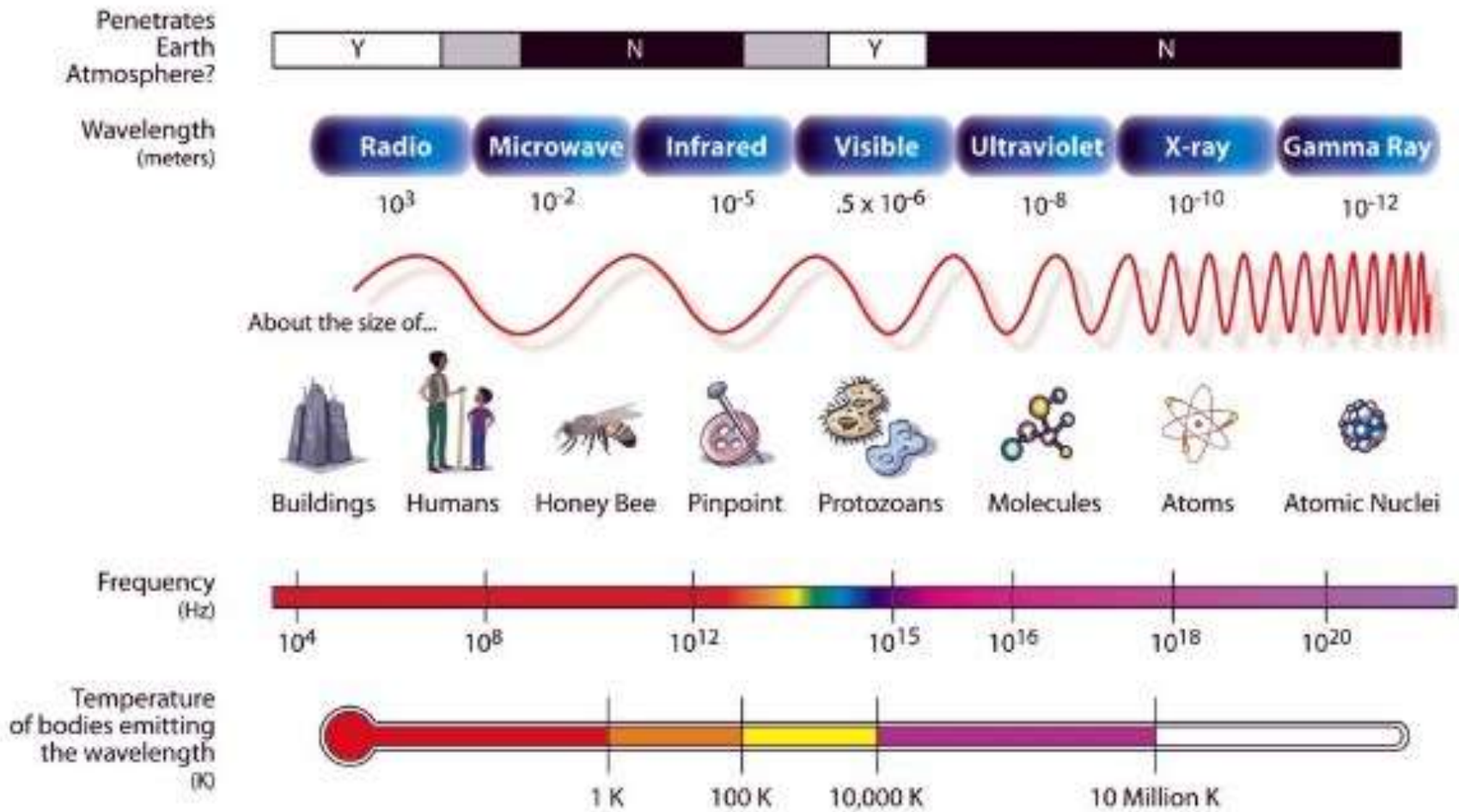
The risk at high exposures is heating or electrocution  
At low exposures there is no evidence of a cancer risk, apart from a weak association of high EMFs and childhood leukaemia



# What is the physical difference between ionising and non-ionising radiation?



# A schematic view of the radiation spectrum



# Scientific basis for risks from ionising radiation

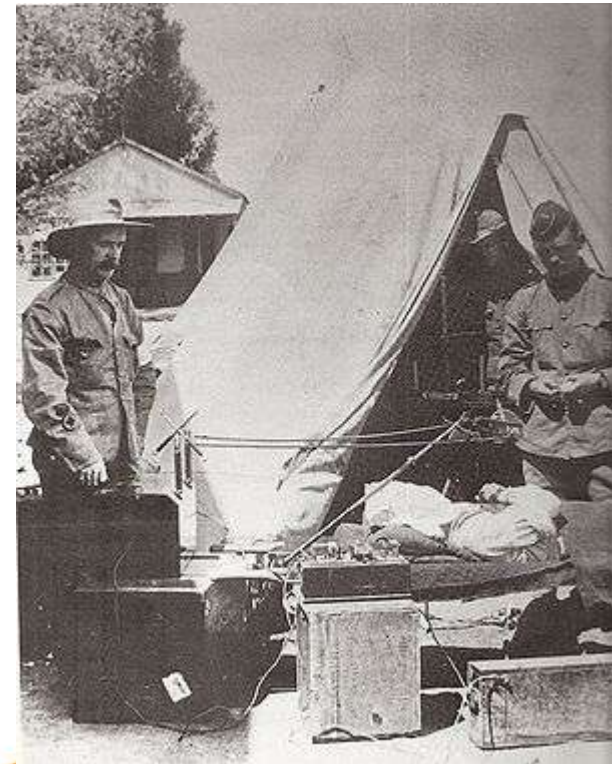


People have been exposed to artificial sources of ionising radiation since the 1890s.

The first casualties were scientists and medical professionals who used the sources.

The International X-ray and Radium Protection Committee was set up in 1928 by the International Congress of Radiology.

It was re-structured as the International Commission on Radiological Protection (ICRP) in 1950 to include protection from non-medical uses.



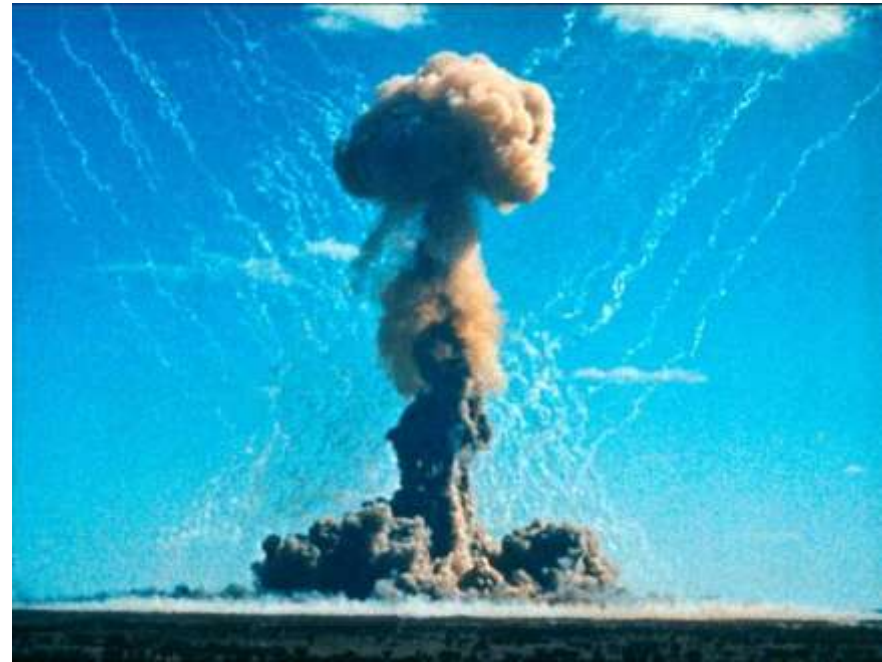
# Scientific basis for risks from ionising radiation (2)



In 1955, the United Nations set up its Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to assess and report levels and effects of exposure to ionizing radiation.

This was stimulated by the widespread fallout from the atmospheric testing of nuclear weapons.

There is a strong relationship between ICRP and UNSCEAR. It has become the International scientific consensus.



# Scientific basis for risks from ionising radiation (3)



Ionising radiation is a weak carcinogen



United Nations Scientific Committee  
on the Effects of Atomic Radiation

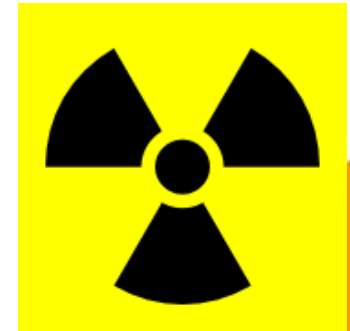
The risk factor for cancer induction is 5% per Sv or 0.00005 per mSv (i.e., risk of cancer in a lifetime)

The cancer risk is assumed to be linear with dose and with no threshold for effects.



The risks have been calculated from data from atomic bomb survivors, radium dial painters, ankylosing spondylitis patients and others.

Internal doses are calculated using biokinetic and dosimetric models.



Alpha radiation is assumed to be 20 times more effective in inducing cancer than electrons, gammas or x-rays

# Other hypotheses



The main challenges to the scientific consensus come from campaign and green groups.

They claim that the risks from ionising radiation are underestimated by factors up to 1000.

They claim that use of risk factors derived from external radiation cannot be used to calculate internal doses

Busby claims that sequential radioactive decay has been underestimated – his 2<sup>nd</sup> event theory

Busby claims that high atomic weight elements can convert natural background radiation into energetic photoelectrons

Low  
Level  
Radiation  
Campaign

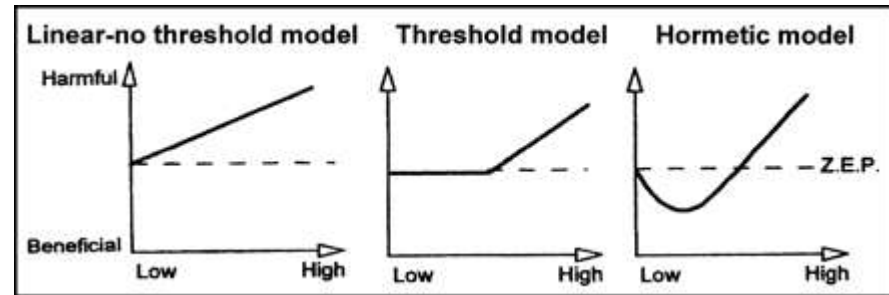


# Other hypothesis (2)



## Hormesis

The LNT implies proportionality between dose and cancer risk.



The carcinogenic risk induced by low doses of ionising radiation cannot be assessed with epidemiologic methods.

Advances during the past 2 decades in radiation biology, the understanding of carcinogenesis, and the discovery of defences against carcinogenesis challenge the LNT model.

Life developed in a bath of ionising radiation and solar ultraviolet radiation and created aerobic organisms requiring (a) defences against the metabolically induced reactive oxygen species, (b) DNA repair, and (c) elimination of damaged cells. Several sets of data show the efficacy of these defences to be much higher at low than at high doses.

The LNT model was introduced as a concept to facilitate radiation protection, but is incorrect at low doses.

# Non-ionising Radiation



# Non-ionising radiation



Here too, the issue is international. The scientific consensus is reflected by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

Its aim is to harness expertise by bringing together independent experts to provide sound advice on the health hazards of non-ionising radiation exposure based on thorough professional evaluations of the published scientific literature.

It was originally a committee formed by the International Radiation Protection Association in the 1970s and was formally chartered in 1992.

Its secretariat is based in Germany



# Epidemiology of Health Effects of Radiofrequency Exposure



There was a comprehensive review of epidemiological studies published in December 2004 by the ICNIRP Standing Committee on Epidemiology, looking at

- 1) many occupational studies carried out over several decades, looking at cancer, fertility, heart problems and cataracts.
- 2) studies of public exposure from radio and TV transmissions, focusing on leukaemia.
- 3) studies of mobile phone users, mostly focusing on brain tumours but also on other cancers and symptoms.



“Results of these studies to date give no consistent or convincing evidence of a causal relation between RF exposure and any adverse health effect.”

However the authors do not rule out the possibility of an association because of the rapid introduction of new technology. Also, “A key concern across all studies is the quality of assessment of RF exposure” and there is “...almost no data is available on the consequences of childhood exposure”.

A Ahlbom, A Green, L Kheifets, D Savitz and A Swerdlow. Epidemiology of Health Effects of Radiofrequency Exposure. *Environmental Health Perspectives* **112**(17), 1741-1754, 2004.

# Power Lines and Childhood Leukaemia



Study of cancer data for 29,000 children aged up to 15 years old. in England and Wales between 1962 and 1995.

Children whose birth address was within 200 metres of an overhead power line had a 70% increased risk of leukaemia. Children living 200 to 600 m away from power lines had a 20% increased risk.



About five of the 400 cases of childhood leukaemia every year may be linked to power lines - which is about 1% of cases

Draper G, Vincent T, Kroll ME, Swanson J. Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study. *BMJ* 2005;330: 1290. (4 June.)

# Example of proxy measures of harm



Journal of  
Epidemiology and Community Health

EG Knox, Roads, railways, and childhood cancers *Journal of Epidemiology and Community Health* 2006;**60**:136-141;  
doi:10.1136/jech.2005.042036



**Significant birth excesses were found within short distances of bus stations, railway stations, ferries, railways, and A,B class roads, with a relative risk of 2.1 within 100 m, tapering to neutral after 3.0 km. About 24% of child cancers were attributable to these joint birth proximities. Roads exerted the major effect.**

# Scientific Evidence



Convincing evidence of a health effect requires

Effects on humans

Effects on animals

Biological effects

Anecdotes

For ionising radiation, there is evidence of a cancer risk in all the above categories.

For non-ionising radiation, there is a weak association for childhood leukaemia and EMFs, and some biological evidence for RFs.