

IMPACT OF THE SIX GENERATION WIRELESS SYSTEM ON HUMAN BODY

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Abstract

Research into 6G wireless communications is accelerating as 5G mobile networks are being deployed. 6G and other future wireless communications are expected to utilize THz technology. Every day, nonionizing electromagnetic radiation is exposed to people. Without this kind of radiation, it would be impossible to use a wide range of applications. Non-ionizing radiation's potential to harm human health or else have an impact on biological systems is an importance topic. In this paper, we examine THz technology has been affected on the human body and biology effects in it. This paper has been analyzing the information pertaining to the influence of high frequency radiation (THz) on organism; the results indicate that terahertz radiation may influence biological cells by causing membrane alterations, proliferation, and the production of pores. As a result, further research is needed to develop safe use guidelines for terahertz body-centric applications. We conclude that biological systems, such as cells from the bloodstream, have revealed a lack of genotoxic and cytotoxic properties, as well as changes in the stability of the membrane or structure and specialization. There are indications that terahertz radiation may limit DNA synthesis, cause changes to neurons, and even cause aneuploids, as shown by one study. Then, it would be extremely important to determine frequency, time, and power dependency.

Keywords: THz radiation, biological effects, Human body, Blood cells, Sixth generation.



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Introduction

The challenge of growing communication capacity due to the massive interchange of information necessitates revolutionary enhancement of data transmission rates in current and future wireless communication systems [1]. The utilization of higher frequencies in the millimeter-wave (mm-wave frequencies) and ultrahigh frequency (THz) ranges., as well as their applications, are a recurrent theme across various research initiatives [2]. The following sixth-generation (6G) technology for wireless communication is anticipated to heavily rely on THz-band communications [3]. The only radio-frequency (RF) spectrum region that is still untapped for communications is the higher frequency (THz) band, which lies within the microwave spectrum and optically bands. As a result, wireless communication technologies in the microwave and optical bands are anticipated to advance to support THz communications. THz frequencies start at 100 GHz in terms of RF communications, and the mmWave band is located below. Higher frequencies under 10 THz (the far-infrared), from the viewpoint of optical communication, are shown in Fig. 1 as THz frequencies. The THz range spans 300 GHz–10 THz, In accordance to the IEEE 802.15 High-frequency Interest Association (IGthz) [4]. The higher frequency (THz band) offers a wide range of medical uses, characterizing tablet coatings, as well as researching medicines, skin diseases, oral healthcare, oncology, and medical imaging [5]. THz waves, like RF and microwaves, are non-ionizing, non-destructive, and essentially safe to expose people to. However, due to their shorter wavelength (1 THz = 0.3 mm = 300.0 μ m in length), they provide finer resolution for imaging than microwaves. THz waves have been utilized to create fine images for medical and security applications, despite the fact that their depth of penetration into most materials is not as good as microwaves, but it is superior to IR and visible light and can expose concealed objects on people and in packages. Friis' formula determines radio propagation path-loss (L_p), which is an important measure for wireless communication and imaging.

$$l_p = 10 \times \log\left(\frac{P_t}{P_r}\right) = 20 \log f + 20 \log r - 147.6 \text{ (in dB)} \quad (1)$$

where P_t is the power of the transmitter, P_r the power of the receiver, f the frequency, and r the distance [6].



Fig.1: THz Frequencies [6].

Effects of the THz Frequency on Health

A mix of positive and negative emotions are always sparked by the introduction of any new technology. The main focus of attention today is 5G technology, and a sizeable portion of people strongly believe that 5G has a harmful impact on human health [7]. Two groups of radiations can be distinguished in terms of how electromagnetic waves affect people:

- **Ionizing Radiation:** X-rays as well as gamma rays are two types of radiation with sufficient power to ionize the atoms of living cells. Exposure to this radiation increases the risk of cancer and cell death.

- **Non-Ionizing Radiation:** which do not ionize living cells, cannot cause cancer or cell death. However, the energy of such radiation can still cause molecules to vibrate, resulting in additional health concerns [8].

Non-ionizing radiation is further classified into thermal and non-thermal impacts of radiation. Authorities and NGOs are working to create exposure limits to prevent the overheating effect on people's bodies [9].

Body-centric THz device use may result in increasing exposure of the body of humans to electromagnetic energy at significantly greater frequencies, increasing concerns about the safety of this technology. In order to establish the appropriate safety limits, it is vital to comprehend how THz radiation affects in human life as shown in Fig.2.[10] Non-ionizing radiations can still be detected in the THz spectrum. THz radiation's low transmission energy makes it extremely unlikely that it will damage living cells' chemical connections. It has been identifying two well-known mechanisms for the way terahertz vibrations affect biological objects:

- **Thermo effect.:** The significant consumption of primarily continuous higher frequency waves upon water causes warmth in the body of human, which has a knock-on effect on biological processes [11].

- **Non-Thermo Effect:** Higher frequency (THz) waves can cause harmonic impacts in DNA molecule, which according to some circumstances may modify the molecular dynamics and disrupt local hydrogen bonds between DNA strands, as well as change the expression of certain genes [12].

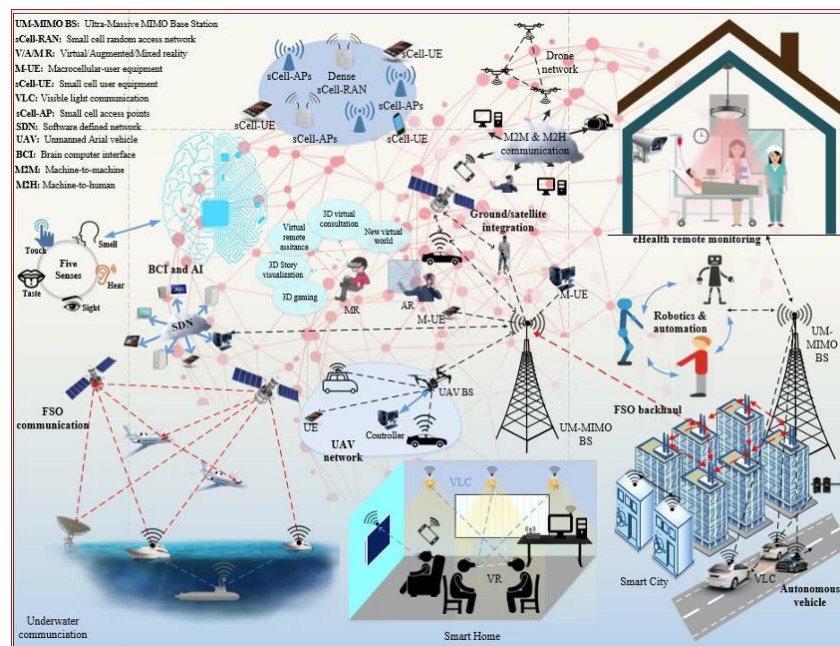


Fig.2. Applications of Terahertz (THz) spectroscopy in Human Life [10].

Related Work

Gerald J. Wilmink studied the influence of conformation on biopolymers (proteins and DNA) that describe the impacts of higher frequency (THz) radiation on cell membranes [11]. In the Third Military Medical University, the researchers also discuss the potential biological impacts of higher frequency radiation during its biological uses and they have been suggesting future opportunities for this cutting-edge technology. The study investigated the issue of precisely predicting the specificity of high-frequency biological effects, as well as the repeatability of experimental results. These issues are brought on by the rarity and uniqueness of THz systems as well as the lack of unitary irradiation protocols [13]. Due to their growing use and thus rising human exposure, millimeter and terahertz radiation are given special consideration. The active transport across cell membranes is known to be altered by MMWs, so that in this study the researchers it has been suggested that high-frequency radiation may interact with DNA and result in genomic instability, these and occurrences were examined. In this study the researchers it has been suggested that high-frequency radiation may interfere with DNA and result in genomic instability, these and other occurrences are examined [14].

Results and Discussion

The effects of exposing plasma, the epidermis and neurons. To high-radiation (THz wave) are investigated through a number of experiments. Multiple scenarios are explored by varying various parameters [15]. Providing the frequency range, the radiation's frequency, its intensity, and the exposure duration, where some of these examples demonstrate how THz radiation affects blood cells [16].

A. Isolated molecules

Antigenic, biological molecules, and synthetic liposomes used as cellular membrane prototypes are just a few examples of the biological systems that have been studied in isolation. The initial research for this subject had been completed in the 1970s When erythrocyte and ethanol dehydrogenase had been exposed to radiation as well as their physiological consequences were examined, they used a 3.5 MHz/s sweep irradiation, shifting the frequency from 0.075 to 0.115 THz. The period of exposure is likely predicted to take approximately three hours [17]. Also, different research identified effects on albumin, namely its progesterone binding capacity. Increased binding capacity was seen after exposure to 10 mW of ionizing radiation at a comparable band of 3.6 THz for 60 minutes [18].

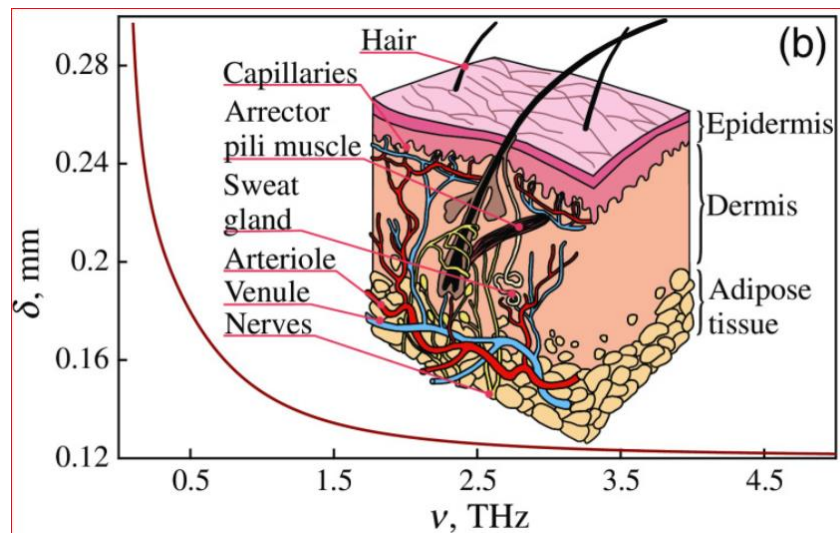


Fig.3. THz optical properties of the skin (epidermis)[19].

B. Blood cells

The bulk of research (four) examining the effects on blood cells were carried out as part of the Terahertz-Bridge project, which sought to identify lymphocyte genotoxicity. Erythrocytes were used in two other studies that have been examined other outcomes such the integrity of the membranes, DNA production, and accumulation of platelets[20]. For the initial investigation, cell proliferation and the rate of occurrence of micronuclei a sign of cytogenetic DNA damage were looked at 0.05 mW/cm² of pulsed 0.120 THz radiation was applied to lymphocytes from six separate donors for 20 minutes, while 0.03 mW/cm² of pulsed 0.130 THz radiation was applied to lymphocytes from three different donors. Neither the proliferation nor the frequency of micronuclei changed much [21].

After irradiating blood cells with 3.678 THz radiation at a strength of 25 mW, a different examination was carried out on the results. After being exposed to radiation for 30 minutes, lymphocytes were examined for functionality and generation of DNA synthesis, while hemoglobin had thirty- and ninety-minute exposures before being examined for the strength of the membrane and blood release from the living cells. Terahertz radiation has an adverse effect on viability while favoring DNA synthesis. Only in hypo-osmotic conditions; normal conditions had no effect on the integrity of the membrane [22]. Blood samples from angina patients were analyzed in a different study (Kirichuk et al., 2008a). Sockett, a NO-donor medication used to treat coronary heart disease, was applied to some blood samples. Employing 0.240 Terahertz frequency at 1 mW/cm² for 15 minutes, blood samples and/or Sockett were exposed. Regarding this study, it is yet unknown if any patients received radiation treatment. Where Blood samples that had been given isoket shown a pronounced reduction in viscosity. The viscosity of the irradiation isoket was further reduced. Neither aggregation nor deformability of erythrocytes were affected by the treatment. Blood samples that had undergone radiation prior to receiving isoket treatment showed the same results [23].

Conclusion

In this article, we investigate the impacts of high frequency radiation on the health of humans. We conclude on biological systems, such as cells from the bloodstream, have revealed the lack of genotoxic and cytotoxic properties, as well as changes in the stability of the membrane or structure and specialization. There are indications that terahertz radiation may limit DNA synthesis, cause changes to neurons, and even cause aneuploid, as shown by one study. Then, it would be extremely important to determine frequency-, time-, and power-dependency. It has been conclusively shown that high power radiation causes tissue damage as a result of temperature rise. And lastly, it's important to do investigations involving human exposure.

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