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Perilous Impact of Microwave Emission on Inexperienced Environment: A Review

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Abstract: *The present paper is an outgrowth of attention particularly felt at the academic and research level towards environmental fortification strategies. The microwaves describe the electromagnetic waves that frequencies lie between 1 GHz to several hundred GHz. The Telecommunication industries have a preference this frequency band for their transmission because lower frequency band has already been occupied. With numerous advantages in the transmission, these radiations have the perilous impact of high-frequency radiation on the in expert and innocent environment. There has been a phenomenal advancement in the field of microwaves but there have been fewer attempts at consolidating the various harmful and nonthermal impacts of ultra high-frequency radiations on our living environment. The impact of microwave radiations in a range of environment-related heterogeneous systems has been reviewed.*

Keywords: *Microwave emission, perilous effect, Nonthermal effect, dielectric cheating.*

I. INTRODUCTION

Evolution of life begins under the influence of inexperienced and innocent environment. It was expected that the natural environment would remain in vigorous nature and will help in functional activities of organisms. But the modern living standard of human being, our environment getting affected to great extent by means of dangerous disasters created by the human being through so-called technological advancements. In early 80's radio frequencies were mainly from telephone lines, Radio and Television transmitters located in remote places outside the cities and at very high places. Later on, an introduction of wireless communication has caused a tremendous increase in electromagnetic pollution in the entire world. Electromagnetic Energy (EME) stored in an electromagnetic field, emitted whenever electricity is generated or used. Radiofrequency energy is a subset of EME covering the frequency ranges 3 KHz-3000 GHz [1]. It also referred to as Radiofrequency (RF) or more often Radiofrequency Radiation (RFR). Electromagnetic radiation consists of electric and magnetic energy moving together through space at the speed of light; EME is emitted from sources such as computer networks (GSM, GPS, WLAN, WPAN, and Bluetooth), electrical equipment (e.g. Radio transmitters and receivers, RADAR, Microwave transmitters) and electrical appliances (e.g. Televisions, Smart mobile phones, and Microwave ovens). Smart Mobilephones produce RF radiations that are the part of the electromagnetic radiation spectrum. Most mobile phones transmit and receive RF radiation of frequencies band between 800 MHz and 2.2 GHz [2].

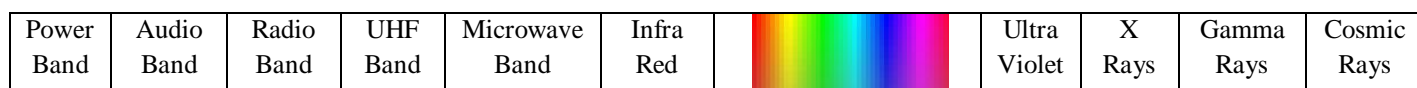


Fig. 1 Electromagnetic Frequency Spectrum

When human body exposed to electromagnetic radiation present in the environment, some radiation being absorbed by it [3]. Radiofrequency Electromagnetic field interacts with human body through thermal effect and induced a current. The proportion of interaction depends on frequency and intensity of electromagnetic radiation. The amount by which the body is influenced by electromagnetic field is determined by the field generated within the body. Nowadays the exhaustive use of smartphones, wi-fidevices, internet signal routers, switches, and advanced high-frequency receivers, transmitters installed on the apartment buildings has contributed too much concern about the effect of radiation emission. The mobile phones emit EMR while they are simply turned ON; there is no effect whether or not a call is made. Some scientific studies have found evidence of adverse effect from mobile phone exposure other has not, so some people report symptoms after extensive mobile phones use, while others do not. The exposure to EMF can be characterized by several different parameters (field strength, field direction, field orientation in relation to the body exposed, field complexity and so on), though it is not known which of these parameters are associated with risk to human health and the organisms. The impact of these frequencies ranges from personal health, the pollution of the earth, global weather to the entire aspect of life on earth. The biological and health consequence of these exposure conditions needs to be explored. Recommended exposure

limits to RFR are set well below the levels where any significant heating (thermal effects) could occur. Nowadays Global Warming or Climate Change becomes a greater issue with the increase of telecommunications on terrain, satellites and the use of microwave frequencies. High-frequency electromagnetic radiations, threatening not only our innocent green environment but even our long-term survival. More powerful and impersonal weapons, endless wars, rapid changes in communication technology may lead to an unstable global climate, weather disasters, destruction of extraordinary species of ecology and environmental devastation. It is a need of the hour to find a precise solution to put our house secure, and we've got to do so fast; otherwise, the rapid descent of our civilization towards collapse seems unavoidable.

The objective of this review is to study the perilous impact of microwave emission on the inexperienced environment. A review of existing literature on socio-demographic, geographical distribution of Electromagnetic radiations, factors responsible for the hazardous effect on the green environment and the key factors that can play a role in controlling the impact of RF frequency emission indicates that the available data continues to be incomplete in terms of representing the realities within different parts of the world. As per proposed work, the review has been categorized into four parts. a) Measurement of Radiofrequency Radiation. b) The biological effect due to RF energy. c) Effects on exposed wildlife including Effects on birds, mammals, amphibians, insects, trees, and plants. d) Global warming and Climate change.

II. MEASUREMENT OF RADIOFREQUENCY RADIATION

An RF electromagnetic wave has both an electric and a magnetic field component and it is often convenient to express the intensity of the RF energy at a given location in terms of units, specific to each EM component, e.g. "Volts per meter" (V/m) is used to express the strength of electric field (E) and the unit "amperes per meter" (A/m) is used to express the strength of Magnetic Field (H). Similarly, the unit used for characterizing the total electromagnetic field is "Power Density", commonly expressed in terms of watts per square meter (W/m^2).

A. Specific Absorption Rate (SAR)

When the whole body (biological tissue) is exposed to radiofrequency radiation, the Radiofrequency energy gets absorbed. The quantity used to measure the rate at which RF energy is actually absorbed in a body is called "Specific energy Absorption Rate". It is usually expressed in units of watts per kilogram (W/Kg.). The induced EM field in biological tissue is a function of body geometry, tissue property, and the exposure conditions. Once the induced EM field is known, quantities such as current density (J) and specific energy absorption rate (SAR) are related to it by simple conversion formulas. In this case, for an induced electric field E in V/m², the induced current density is given by

$$J(x, y, z) = \sigma(x, y, z)E(x, y, z) \quad (1)$$

where σ is the electrical conductivity of biological tissue and SAR is given,

$$SAR(x, y, z) = \frac{\sigma(x, y, z)|E(x, y, z)|^2}{\rho(x, y, z)} \quad (2)$$

where ρ is the mass density of the tissue (kg /m³).

When a standing ungrounded human adult exposed to RF radiation of about 70 MHz, "the whole body" SAR is maximum. Because of "resonance" phenomenon, contemplation of children and grounded adult, RF safety standards are most restrictive in the frequency range of about 30 to 300 MHz [4]. In fact, heat generated in the medium is proportional to the absorbed power. Accordingly, biological effects of RF energy depend on the rate at which is absorbed. Research by the International Commission of Non-Ionizing Radiation Protection [5] recommended that the radiation emitted by mobile phones should be at levels between a SAR of 0.3 and 2 watts per kilogram. The World Health Organization (WHO) had summarized the results of research studies on the biological effect due to extremely low-frequency EM Fields, which are performed in the laboratory on animals and humans. The studies identified the Evidence for thermal effect or exposure to EM Field. The most adverse health effects of continuous emission of radio frequency radiation with digital mobile phones and microwave radiation with intensity less than 10 mW/cm² are not probable to affect physiology mainly through thermal mechanisms. But very little information is available on the non-thermal influence of EM field caused by these phones on human tissues and more specifically on Brain tissues[6]. Freude and his team in 1998 performed series of nondestructive experiments to investigate the biological effect at much lower levels such as leukemia (2-8 μ W/cm²), cancer (0.1-1

$\mu\text{W}/\text{cm}^2$), memory endurance ($8 \times 10^{-4} - 0.4 \mu\text{W}/\text{cm}^2$) [7][8].

B. Non-Ionization effect

"Ionization" is a process by which electrons are stripped from atoms and molecules. This process can produce molecular changes that can lead to damage in biological tissues, including the effect on DNA, the genetic material of living organisms. This process requires interaction with the high levels of electromagnetic energy. These types of electromagnetic radiations with enough energy to ionize biological material include X-rays and Gamma radiation. Therefore X-rays and Gamma rays are examples of ionizing radiation. The energy levels associated with RF and microwave radiation on the other hand, is not great enough to cause the ionization of atoms and molecules and RF energy is, therefore, a type of non-ionizing radiation. Another type of non-ionizing radiation includes visible and infrared light. Often the term "radiation" is used, colloquially, to imply that ionizing radiation (radioactivity), such as that associated with the nuclear power plant. Ionizing radiation should not be confused with the lower energy, non-ionizing radiation with respect to possible biological effect, since the mechanism of action is quite different.


Electromagnetic Spectrum								
Non Ionizing Radiation					Ionizing Radiation			
Extreme Low Frequency	Very Low Frequency	Radio Frequency	Microwave Frequency	Infrared Frequency	Visible Band 	Ultra Violet Frequency	X-Rays	Gamma Rays

Fig. 2 Electromagnetic Frequency Distribution

III. BIOLOGICAL EFFECT DUE TO RF ENERGY

What kind of EM radiation will lead to the greatest degradation of wildlife and global environment has been the topic of debate. The OET Bulletin in 2010 has submitted the in-depth report on biological effects that result from heating of tissue from exposure to RF energy which is often referred to as "thermal effects" [9]. It has been known for many years that exposure to very high levels of RF radiation can be harmful due to the ability to heat biological tissue rapidly. The reason is that, as the microwaves penetrate to the surface of the biological tissue, the water, have microwave frequencies passing through them. The water molecules within the biological tissue vibrate at incredible speeds, creating molecular friction which is responsible for the heating of the subject. The structure of the water molecules are torn apart and vigorously deformed. This friction causes heat which is called dielectric Heating. This is the principle by which microwave ovens cook food [10]. Exposure to very high RF intensities can result in heating of biological tissue and an increase in body temperature. Tissues damage in humans could occur during exposure to high RF levels because of the body's inability to cope with or dissipate the excessive heat that could be generated. Two areas of the body, the eyes, and the testes are particularly vulnerable to RF heating because of the relative lack of available blood flow to dissipate the excess heat load.

At low levels of exposure to radiations i.e. levels lower than those that would produce significant heating; the evidence for production of harmful biological effects is ambiguous. Such effects have been referred to as. "Non- thermal" effects. A number of reports have appeared in the scientific literature describing the observation of a range of biological effects resulting from experimental research has been unable to reproduce these effects. Furthermore, since much of the research is not done on whole bodies, there has been no determination that such effect constitutes a human health hazard. It is generally agreed that further research is needed to determine the generality of such effects and their possible relevance to human health. In the meantime, Standards-setting organization and government agencies continue to monitor the latest experimental findings to confirm their validity and determine necessary changes in safety limits are needed to protect human health.

IV. EFFECTS ON EXPOSED WILDLIFE

A. Effects on birds

1) *Effects on the bird community at an urban park.*: Microwaves may be affecting bird populations in places with high electromagnetic pollution. Since several antennas were installed in proximities, the bird population has decreased a number of species and reduction of breeding couples has occurred. In the urban park "silent areas" that contaminated with high microwave radiation ($>2 \text{ V/m}$). It is found that where previously different couples usually bred and later disappeared.

2) *Effects of phone mast microwaves on house sparrow*: In monitoring a house sparrow (*Passer domesticus*) population in the vicinity of Cellular Phone Base Station, the total productivity in nests located within 100m of antennae was 0.50 ± 0.12 . For those located further

than 300 m. the result was practically doubled, with an average of 1.1 ± 0.16 . Very significant differences among total productivity were found. These results indicate the possibility that microwaves are interfering with the reproduction of these birds.

3) *Possible physiological mechanisms of the effects found in birds:* Current scientific evidence indicates that prolonged exposure to EM fields at levels that can be encountered in the environment, may affect the immune system by affecting biological processes. A stressed immune system may increase the susceptibility of a bird to infectious diseases, bacteria, viruses, and parasites. The plumage of the birds exposed to microwaves looked, in general, discolored and lack of shine. This not only occurred in ornamental birds such as peacocks but also in wild birds: such as. Black-lored tit, Indian jungle crow, house sparrows, etc (personal observation). We must mention that plumage deterioration is the first sign of weakening or illnesses in birds since damaged feathers are a sure sign of stress. Prolonged mobile phone exposure may have negative effects on sperm mortality characteristics and male fertility. Long-term continuous or daily repeated EMF exposure can induce cellular stress responses at non-thermal power levels that lead to an accumulation of DNA errors and could become a health hazard due to a possible accumulation of brain tissue damage. It is possible that each species and each individual, show different susceptibility to radiation since vulnerability depends on genetic tendency, physiologic and neurological state of the irradiated organism. Different susceptibility of each species has also been proven in wild birds exposed to electromagnetic fields from high-voltage power lines.

B. *Effects on mammals*

1) *Alarm and aversion behavior:* Mice in an experimental group exposed to microwave radiation expressed visible individual panic reaction, disorientation and a greater degree of anxiety. In the sham-exposed group, these deviations of behavior were not seen and all animals show collective defense reaction [11]. Microwave radiation at 1.5 GHz pulsing 16 ms. at 0.3 mW/cm² power density, in sessions of 30 min/day over one month produced anxiety and alarm in rabbits [12]. Electromagnetic radiation can exert an aversive behavioral response in bats. Bat activity is significantly reduced in habitats exposed to electromagnetic field strength greater than 2 V/m. During a study in a free-tailed bat colony (*Tadarida teniotis*) the number of bats decreased when several phone masts were placed 80m from the colony [13].

2) *Deterioration of health :* K.J. Ferniein 2001 personally observed that animals exposed to electromagnetic fields suffered from deterioration of health and changes in behavior [14]. There were proof of frequent death in domestic animals: pigs living near mobile telecommunication base stations (personal observation). A link between electromagnetic field exposure and higher levels of oxidative stress appears to be a major contributor to aging, neurodegenerative diseases, immune system disorders and cancer in mammals.

3) *Problems in reproduction :* Other studies find a decrease of fertility, increase of deaths after birth and dystrophic changes in rat's reproductive organs. Intermittent exposure showed a stronger effect than continuous exposure. Brief, intermittent exposure to low frequency EM fields during the critical prenatal period for neurobehavioral sex differentiation can demasculinize male scent marking behavior and increase accessory sex organ weights in adulthood. In humans, magnetic field exposures above 2.0 mW were positively associated with miscarriage risk. Exposure of pregnant women to mobile phone significantly increased foetal and neonatal heart rate and significantly decreased the cardiac output.

4) *Nervous system :* Microwaves may affect the blood-brain barrier which lets toxic substances pass through from the blood to the brain. Researchers examined the effect of microwave exposure to a GSM-like frequency of 970MHz pulsed waves on the memory in rat's by means of an object recognition task. The rats that have been exposed for 2 months show normal exploratory behavior. The animals that have been exposed for 15 months show derogatory behavior. They do not make the distinction between a familiar and an unfamiliar object. In the area that received radiation, exposed children had less developed memory and attention, their reaction time was slower and neuromuscular apparatus endurance was decreased. Electromagnetic radiation caused modification of sleep and alteration of cerebral electric response (EEG) and may cause aggressiveness in people and animals [14].

C. *Effects on amphibians*

A. *Balmoriin* 2006 has put the critical remark on the disappearance of amphibians and other organism which is a part of the global biodiversity crisis. An associated phenomenon is the appearance of large numbers of deformed amphibians [15]. The problem has become more prevalent, with deformity rate up to 25% in some populations, which is significantly higher than previous decades. The author also added that electromagnetic pollution (in the microwave and radiofrequency range) could be a possible cause for deformations and decline of some wild amphibian populations. Exposure to the pulsed electromagnetic field produced abnormal limb regeneration in adult Frog tadpoles (*Rana temporary*) developed under electromagnetic field (50 Hz. 260 A/m) has increased mortality. Exposed tadpoles developed more slowly and less synchronously than controlled tadpoles and remain at the early stages for a longer period.

1) *Effects on insects* : Alfonso Balmori in 2009 briefly explored the study and offered expert comment on the effect of microwave radiation on the key species (insects) of ecosystems which are very sensitive to EM radiation and warning to us there will be a threat to natural scenery. R.L. Carpenter in 1971 found that Yellow mealworm (*Tenebrio Molitor*) if continuously exposed by 10 GHz microwave power at 80 mW for 20 to 30 min and 20 mW for 120 minutes, there is an increase in the proportion of insects with abnormalities or deceased [16]. The reproductive capacity of the species reduced by 50-60% in modulated radiation conditions (emission while talking on the phone) and 15-20% with radiation unpopulated (with the phone silent). The results of this study indicate that these radiations affect the gonadal development of insects in an athermal way. The author reported that radio frequencies (GSM) are highly bio active and can cause significant changes in physiological functions of living organisms. A study in rural part of India finds a strong association between decrease in ant and beetle diversity with the electromagnetic radiation exposure. Another serious effect found near the electromagnetic antenna is an absence of flies, even in summer, was found (personal observation). In recent years a "colony collapse disorder" is occurring. Some authors reported that this type of disorder is the effect of pesticides and increasing electromagnetic pollution. The disappearance of insects could have a very serious concern on bird's health caused by a lack of food, especially at the first stages in a young bird's life.

2) *Effects on trees and plants* : The microwaves may affect vegetables and trees found surrounding the object emitting and radiating the electromagnetic waves. In the vicinity near "Radio Station" directly transmitting the electromagnetic radiation, the Pines trees (in northern part of India) experience a lower growth ratio. This did not occur beyond the area of Radio station. There is a significant negative correlation between increase tree growth and intensity of the electromagnetic field. In another study investigating cell ultrastructure of pine needles exposed by the same radar, there was an increase of resin production and was interpreted as an effect caused by radiation, which would explain the aging and declining growth and viability of trees subjected to microwave radiations. A low germination of seeds of pine trees is another serious impact. When perennial aquatic plant such as common duckweed, exposed to a power density between 0, 1 and 1.8 W/cm² had lower longevity, problems in reproduction and morphological and developmental abnormalities compared with a control group who grew up far from the radio station. It was revealed that the ratio of the two main types of chlorophyll was decreasing logarithmically to the increase of daily exposure time. The exposed tomato plants to low level electromagnetic fields for short period (10 min) measured changes in abundance of three specific mRNA after exposure, strongly suggesting that they are the direct consequence of application of radio-frequency fields and their similarities to wound responses suggests that this radiation is perceived by plants as an injurious stimulus. Non-thermal exposure to radiofrequency fields induced antioxidative enzymes in lesser duckweed foliage located inside the main lobe (beam) of EM radiation, look gloomy and weak, possibly slow growth and a high susceptibility to illnesses and plagues. It is found that tops of plants are dried up where the main beams are of radiation directed to, and they seem to be most vulnerable if they have their roots close to water.

V. GLOBAL WARMING AND CLIMATE CHANGE

Richardson in 2017 has prepared the document on Climate Change and Global warming. His article literature reported that microwave frequencies are polluting our atmosphere and Earth. The basis of the "Microwave" theory is that microwave communication leading to global warming and climate change [17]. But some antagonist people commented that the microwaves used by wireless, radar, mobile, and satellites are so weak that they could not affect the world. Experimental investigations put strong evidence that "constant wave bombardment affects the natural pattern and flow of the earth's atmosphere". The heating and molecular friction caused by RF and microwave frequencies cause erratic weather patterns.

A. *Effect of Microwave Radio Frequencies and Earth-orbiting Satellites*

The TV's, Cell Phones, Weather Stations, and a host of others make use of Microwave Radio Frequencies for wireless communication. The Satellite transmitters and Earth antennas transmit UHF and higher microwave frequencies all over the planet. As the microwaves penetrate to the surface, the water, ice, and atmosphere have microwave frequencies passing through them. This causes friction in the ice and water at the molecular level. This friction causes heat which is called RF Heating.

There have been thousands of satellites launched into outer space and even more, antennas built that transmit to those satellites on Earth. The use of Microwave Radio Frequencies has a direct link with Global Warming or Climate Change. With the overlapping of each satellite footprint, it is clear that as we increase the number of satellite transmissions and the use of microwave transmissions on earth, the Global Warming or climate variation increases.

B. *Effect of Green House Gasses*

Some Scientists have developed different "Global Warming" or "Climate Change" theories. The most popular theory is the "Greenhouse Gas" theory. According to the theory, gases emitted from "fossil fuel" burning vehicles are blocking outgoing radiation.

Greenhouse gases block radiation from leaving the earth and also block radiation from entering into the Earth’s atmosphere. This creates equilibrium between escaping radiation and entering radiation called “The Earth’s Energy Balance”. The Earth will naturally process the sun’s rays, greenhouse gasses, and other climate occurrences and balance them out.

C. The Radiation Budget

The Earth is not warming in the way the proponents of the “Greenhouse Gas Theory” claim. There is some evidence supporting this theory in the literature. The figure shows that 65% is absorbed and 35% is reflected. Of the 35% that is reflected, only 4% is actually reflected from the surface of the Earth. This also can decrease the emission more particles into the atmosphere. It means the amount of gasses in the atmosphere creates fewer sun rays from entering to the surface, in turn creating less reflection of those rays from the Earth.

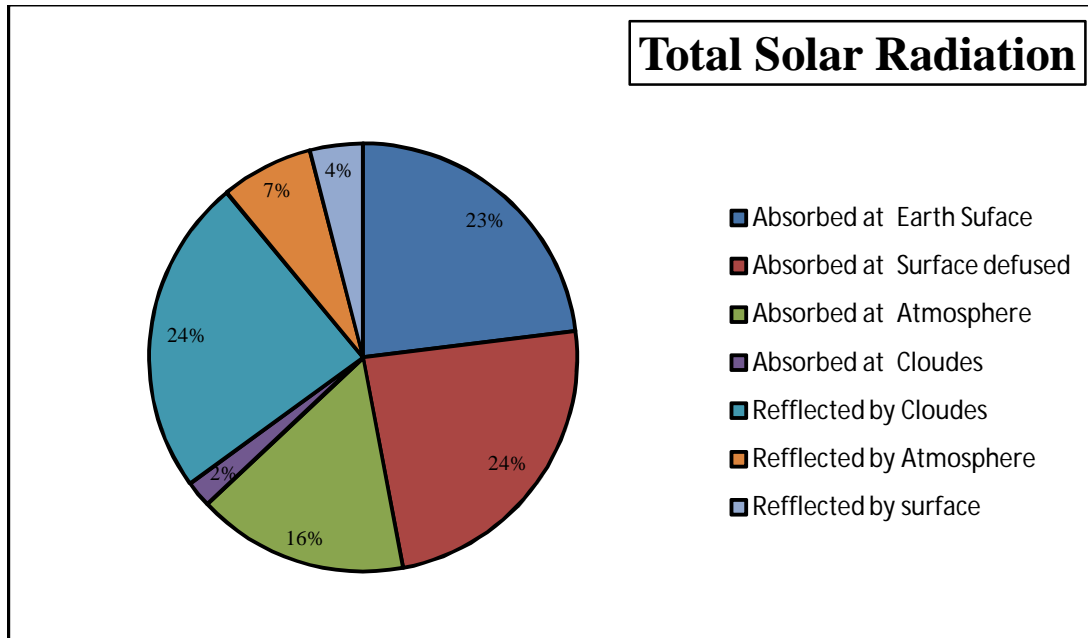


Fig. 3 Total Solar Radiation Distribution over the Globe

D. Global Temperature (Warming)

Global average temperature is one of the most-cited indicators of global climate change and shows an increase of approximately 1.4°F since the early 20th Century. (NOAA–Global Climate Change Indicators). There is not enough evidence to show that greenhouse gases are not only responsible for global warming, which is deliberately being presented by “Greenhouse Gas” adversaries.

VI. CONCLUSION

The possible risks of microwave electromagnetic field exposure of the earth atmosphere area major concern for the society. In the light of current knowledge, there is enough evidence of serious effects from this technology to wildlife. For this reason, precautionary measures should be developed, alongside environmental impact assessments prior to installation, and a ban on installation of phone masts in protected natural areas and in places where endangered species are present. Global Warming or Climate Change is caused by the use of UHF and higher microwave frequencies at an enormous rate. The use of these frequencies must be restricted to prevent Global Warming or Climate Change. Cleaning up the trash in the space and restricting the use of microwave Radio transmission is the solution to global warming and Climate change. This review can be used as a foundation for new exposure limits that take into account non-thermal effects of microwave radiation from various sources of UHF radiations. The goal of this Review work is to determine the hazardous effect of SAR on the entire innocent earth environment exposed to RF fields.

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