REGULAR AND REVERSE FLUXES OF MICROWAVE RADIATION FROM PHYSICAL AND BIOLOGICAL OBJECTS

G.V. PONEZHA, S.P. SIT'KO, *YU.A. SKRIPNIK, A.F. YANENKO

Scientific Research Center of Quantum Medicine "VIDHUK", Kiyv, 252033, Ukraine

**State Academy of Light Industry of Ukraine, Kiyv, 252011, Ukraine*

Abstract. The results of experiments on observation of microwave electro-magnetic radiation emitted by objects of physical and biological nature are considered and discussed.

Key words: biological object, radiation capability, microwave electromagnetic radiation, non-equilibrium radiation, negative radiation flux, absorptance, thermal radiation.

Nowadays, vast amounts of experimental and theoretical knowledge have been accumulated, unique in their scientific and practical value. The study was focused upon biomedical effects inherent in low-intensity electromagnetic mm-range radiation (EMR). During experimental study of living objects, the main attention was usually paid to the peculiarities of their physiological reactions depending on the regimes of irradiation by the external EMR and its parameters. Theoretical research within the framework of quantum physics of the alive contributes to the modern idea about the living nature, specifically about a human organism as an integral quantum-mechanical entity whose development is determined by existence of the internal coherent field – the so-called "electromagnetic frame" [1], connected to the environment via biologically active points. The key ideas of quantum physics of the alive are realised in practice as a new technology of medical treatment – microwave resonance therapy. In the context of the above-stated, the study of peculiarities of a living object's emittance of eigen mm-range EMR, by a human body in particular, has a drastic scientific and practical importance of conceptual character for solution of cardinal problems of quantum physics of the alive.

In scientific literature the data are available concerned with registration of electromagnetic radiation of biological objects within decimetre and centimetre wavelength band at the level of $10^{-20} - 10^{-21}$ W/Hz [2, 3]. The problems of measuring the low-intensity mm-range electromagnetic radiation, designing the high-sensitivity measuring equipment and its metrologic support were thoroughly discussed in [4, 5, 6]. The principles stated in these papers formed the basis for construction of high-sensitivity radiometric mm-range measuring system, the latter made it possible to register microwave radiation emanating from a human body [7]. The results of experiments involving observations of mm-range electromagnetic radiation emitted by the objects of physical and biological nature are stated and discussed in the given paper.

Methods of experiment

Experimental studies were conducted with the use of high-sensitivity measurement-information radiometric system (MRS) designed in VIDHUK

Scientific Research Centre of Quantum Medicine. The limiting spectral sensitivity of MRS is $P_{lim} \approx (0.5 \div 0.7) \cdot 10^{-22}$ W/Hz [7].

The receiver of a measuring radiometric system as a physical object obeying Kirchhoff law [8], does not register, in principle, the radiation fluxes corresponding to its eigen temperature T_{rec}. Any indications on a receiver occur only when thermodynamic equilibrium with an object at temperature T_{ob} is taking place. In all cases, the radiometric system's receiver registers only the difference (positive as well as negative) of radiation fluxes, i.e. of a flux being investigated and a flux falling on the device under conditions of thermodynamic equilibrium [9].

It should be noted that for the case of registration of purely thermal radiation, the limiting spectral sensitivity P_{lim} defines such minimal temperature difference $|\Delta T_{min}|$ of the objects being investigated and a receiver that still can be registered by MRS: $|\Delta T_{min}| = |(T_{ob} - T_{rec})_{min}| = P_{lim}/A \cdot k$, where A is an object's absorptance, and k is Boltzmann constant. Specifically, with $P_{lim} \approx 0.7 \cdot 10^{-22}$ W/Hz for matched load $(A = 1)$, we obtain $|\Delta T_{min}| \approx 5K$, and for water $(A \approx 0.44) - |\Delta T_{min}| \approx 11.5K$.

The MRS is characterised by sign invariance with respect to the investigated radiation that consists in the fact that the sign of the output MRS signal is independent of the sign (positive/negative) [9] of input radiation flux. To avoid ambiguity when determining the sign of mm-range EMR flux, during measurements the use was made of illumination of MRS's entry track by positive radiation flux from Porog–3 noise generator. To avoid artefacts, MRS was thoroughly calibrated using specially made standards, adequate to the studied objects with respect to radiation capability within the required frequency range.

The investigated objects (a polished brass bar, a candle's flame, a smouldering wormwood cigarette, water, snow, ice, curried dry skin, portions of skin of a living human organism, etc.) were placed in direct proximity to waveguide megaphone of a radiometric system's receiving antenna. The temperature of the investigated objects was controlled by a thermocouple: copper-constantan, with an error not in excess of 0.1K.

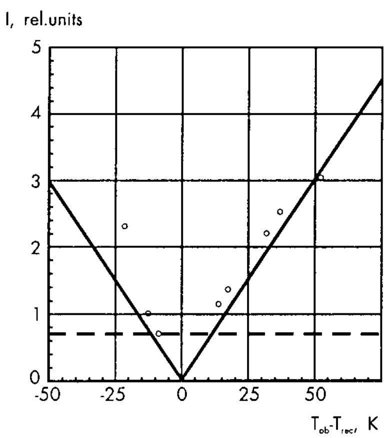

Fig. Temperature dependence of level I output signals of measuring radiometric system (MRS) at registration of electromagnetic radiation in the domain of 60 GHz emitted by water (circles). Continuous lines represent calculated dependences, a dotted line represents MRS's limiting sensitivity level.

The results of experiment and their discussion

The main outcome of the experiments is illustrated by a table and a picture.

First of all, it is worth mentioning that easily prognosticated outcome of the experiments with a heated brass bar and curried dry skin of an animal within the limits of MRS measurements accuracy was confirmed by way of experiment. The bar of pure brass heated to temperature $T_{ob} = 400K$ was oriented so that its flat polished edge was perpendicular to the axis of MRS's receiving antenna. As it was expected, the brass bar almost completely reflecting mm-range microwave electromagnetic radiation, practically does not radiate any microwaves in complete agreement with the laws of thermal radiation [8]. Radiation power within frequency domain of 60 GHz entering the MRS's entry track from the heated brass bar amounts to $\approx 4.6 \cdot 10^{-16}$ W according to our estimate, which is much lower than the system's threshold sensitivity with respect to power. For the same reason, we also observed no mm-range electromagnetic radiation from the curried dry skin, ≈ 3 mm. thick, heated to $T_{ob} = 340K$ which is readily pervious to radiation otherwise.

The table contains the data on absorptance of different objects which, in essence, represents the relative radiation capability, i.e. radiation capability of the real bodies related to radiation capability of the absolute blackbody.

Absorptance A of different objects in the frequency range of 60 GHz

Object	Brass	Curried dry skin	Candle's flame	Absinthe cigarette	Water	
Temperature of object T_{ob}, K	400	340	>680	≈ 480	273	333
Absorptance, A	< 0.04	< 0.04	≈ 0.04	≈ 0.7	0.44	0.44

A smouldering absinthe cigarette used in the traditional Chinese medicine for heating of acupuncture points readily emits mm-range electromagnetic radiation, as well as an ordinary smouldering cigarette. Spectral radiation density of cigarettes makes up $\approx 0.5 \cdot 10^{-20}$ W/Hz; the microwave radiation level of a paraffin candle's flame is by 10 – 12 dB less than that of a cigarette.

Challenging results have been obtained in experiments with water which, as is generally known, absorbs well [10] and, consequently, emanates microwave radiation. Temperature dependence of the level of MRS's output signal during registration of electromagnetic radiation emanating from water in the range of 60 GHz is given in the picture. The presence of positive output signal in case of negative fluxes $(T_{ob} - T_{rec} < 0)$ is stipulated by MRS's sign invariance with respect to the radiation being studied. The obtained experimental results were compared to the calculated data and proved to be in a good agreement with the latter.

In experiments with a human organism it was proved that, first of all, the skin surface is not homogeneous with respect to radiation capability within mm-range wavelength; secondly, the mm-range EMR emitted by separate parts of skin surface changes with time; and, at last, the spectral power of mm-range EMR di: fers, as a rule (in upper as well as in lower directions), from the spectral power c thermal radiation determined by absorptance and temperature of the skin sui face. The last point testifies to regular as well as reverse non-equilibrium radia tion emitted by a living system. The spectral power and the sign c non-equilibrium radiation flux is determined by the value of deviation from th equilibrium number of the matter particles at the respective energy levels [8 rather than by the temperature of eradiating body.

ДОДАТНІ І ВІД'ЄМНІ ПОТОКИ МІКРОХВИЛЬОВОГО ВИПРОМІНЮВАННЯ ВІД ФІЗИЧНИХ ТА БІОЛОГІЧНИХ ОБ'ЄКТІВ

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