ABOVE-BACKGROUND MEASUREMENTS OF SUPERLOW-LEVEL SIGNALS AS AN INSTRUMENT OF COGNITION OF THE ALIVE (METHODOLOGICAL ASPECTS)

S.P. SIT'KO, YU.A. SKRIPNIK

Scientific Research Center of Quantum Medicine «Vidhuk», Kyiv, Ukraine

Abstract. Above-background measurements are used for detection and evaluation of power or intensity of superlow signals the level of which is much less than the eigen-noises power of the measuring equipment and the external noises. In this case, the relation of measured signal to noise is considerably less than a unity and so its direct amplification is inefficient due to still bigger reduction of this relation at the amplifier's output caused by additional eigen-noises. If the signal to be measured is determinated, for example, it is harmonic with the known frequency and phase, then it can be distinguished against the background of noises and jamming by way of synchronous detection at the expense of increasing the time of the output signal averaging. If the measured signal is random with wide frequency spectrum, then it is statistically indiscernible against the background of noises that are also a wideband process. That is why it is impossible to detect by classifical methods the low-intensity informative random signal at the background of eigen-noises and equipment jamming.

Above-background measurements are based on superposition of the measured signal over a background signal which is much stronger than the measured one and then follows scaling and functional transformation of the summed signal and picking out of informative component, proportional to the measured signal. For this purpose three special methods are used laying the base for radiometric equipment: compensation, correlation and modulation ones. In compensation method, the amplified voltage of eigen-noises in the absence of the signal being measured is compensated by the voltage from additional source of the stable voltage. However, inevitable fluctuations of an amplifier's coefficient of amplification and other elements of radiometric channel do not allow for the complete compensating of the background signal by the constant voltage due to instability of the background signal. Under such conditions, it is extremely difficult to detect very little increase of the amplified signal at the incoming of the measured signal to the radiometric channel's input. Prolongation of the time of difference signal averaging for fluctuation suppression is inefficient, since in the noise spectrum there prevail lowfrequency components whose intensity is especially great in the vicinity of zero frequency.

The correlation method envisages dividing of the measured signal into two antiphase signals, amplification of these signals by two independent amplifiers, multiplication and averaging of the amplified signals. The averaging results in suppression of the influence caused by noncorrelated noises of an amplifier, but correlated noises and voltage fluctuations at zero of multiplying scheme remain unsuppressed.

The modulation method is based on periodic interruption of the measured signal at the input of radiometric channel directly after receiving antenna, quadratic detection of the amplified combination of the eigen-noises with the received noise signal, picking out from the noises of a low-frequency envelope with interruption frequency of the measured signal and subsequent synchronous detection of the mixture of envelope voltage with low-frequency noise [2]. And here, in the capacity of the reference signal of a synchronous detector the use is made of low-frequency voltage controlled by interrupter-modulator of UHF-signal. Rather high modulation frequency is chosen (1 KHz and above) in order to be able to leave the domain of high-intensity low-frequency noises and to neutralize only thermal noises in the vicinity of modulations frequency having much lower intensity as compared to the noises in the vicinity of zero frequency.

All the three methods are widely used in radioastronomy for investigation of superlow signals received from cosmos, and also for measurements of radiothermal and plasmic radiations [2]. For this purpose the use is made of huge stationary antennas and special electronic amplifiers with artificial cooling.

The main parameter of a radiometer is a fluctuation sensitivity threshold which is estimated for noise signals by the minimal spectral power density registered by an operator. To reduce it is necessary to increase substantially the time of averaging of an output signal picked out from the noises by way of synchronous detection. That is why the time of averaging of the output signal in modulation radiometers used in radioastronomic observations is chosen to be prolonged (up to 24 hours). The time averaging (accumulation of useful signal) allows to pick out and measure superlow noise signals with spectral power density 10^{20} W /Hz·cm^2. The further reducing of fluctuation sensitivity threshold is limited by the receiving antenna dimensions, UHF–modulator errors and non-identity of parameters of antenna equivalent and the antenna itself, which is periodically switched to the radiometer amplifier at the moments of switching out of the antenna.

The similar complications occur in the study of a human electromagnetic field which manifests itself in environmental space as a kind of noise. Dominating component of this radiation constitutes radiothermal radiation stipulated by equilibrium processes in a human body at the temperature (35-40) °C. The maximum intensity of the spectrum of this radiation resides predominantly in the domain of infrared range. But there is also a radiowave component whose intensity decreases with the increase of the wave length. Radiowave radiation in cm-wave length range is measured by modulation radiometers and small-size contact antennas. In particular, it is possible to determine the temperature of internal organs and tissues of a human by way of measuring the radiation intensity within three-centimeter frequency range [3]. The required temperature sensitivity is provided with the use of a low noisy input UHF-amplifier, the wide passband of this amplifier and narrow passband of the amplifier of modulation frequency voltage. The increasing of precision of the modulation radiometer is achieved with the use of zero modulation method where the signal received by antenna is compensated by a noise signal from the reference UHF-noise generator. The similar effect is attained in case of introduction of the deep negative feedback into a modulation radiometer with subsequent transformation of the direct current output signal into the noise signal. But in this case, the radiometer sensitivity considerably decreases, because not total, but difference signal is amplified in a radiometric channel.

The situation is still more complicated when we deal with detection and measurement of nonequilibrium electromagnetic radiation generated by the living objects within mm-wave range [4,5]. Small sizes of the antenna, intensive radiothermal radiation (equilibrium) determined by a biological object's temperature, the superhigh frequencies range (millimeter waves), for which nowadays there are no small size cooled amplifiers, solid particularly, the necessity in commutational electric equivalent of an antenna, poor decoupling of the levers of switcher-modulators in the super high frequency range, etc., all these factors do not allow to measure equilibrium as well as nonequilibrium electromagnetic radiation, which is weaker than radiothermal one with respect to intensity.

The problems of measurement of mm-range nonequilibrium radiation are discussed in papers [6,7]. We suggested the new method of dividing the equilibrium and noneqilibrium radiation eminating from the living organisms based on design-technological division of the received signal into two signals. One of the signals includes the equilibrium and nonequiblirium components, and the second signal only the equilibrium component. This is reached because the second signal is generated by the special metal-ceramic filter that detains both components of a human body's radiation, but reproduces only a radiothermal component, proportional to the temperature of a body's skin parts being investigated [8].

Both components are interrupted in turn with the help of two UHF-keys operating in antiphase and are summed at the radiometric channel input, forming the single composed signal, modulated by amplitude. Low-frequency envelope of such a signal is proportional to the intensities difference of the above-mentioned two signals. The subsequent quadratic detection and synchronous detection with averaging allow for picking out of the direct current signal, proportional only to nonequivalent component of the received radiation. The required fluctuation sensitivity threshold of a radiometric system ($10^{-21} \div 10^{-22} W/Hz \cdot cm^2$) is reached by way of heterodyne transformation of mm-wave frequency modulated signal with amplification at the intermediary frequency (100-200 MHz).

The carried out research showed that a nonequilibrium radiation component reflects the internal processes taking place in a living organism. It correlates with the influence of the external unfavourable factors (smoking, alcohol, poor nourishing, etc.). The availability of measuring of nonequilibrium radiation of a human makes it possible to diagnosticate physiological state of a patient and to provide the dynamic control in the process of treatment with the aid of microwave resonance therapy (MRT) — the modern technology of quantum medicine in dependence of the affecting parameters: the choice of frequency, intensity, polarization, coherence degree, monochromatics of radiation, time of action, etc.

НАДФОНОВІ ВИМІРЮВАННЯ НАДСЛАБКИХ СИГНАЛІВ – ІНСТРУМЕНТ ПІЗНАННЯ ЖИВОГО (МЕТОДОЛОГІЧНІ АСПЕКТИ)

СІТЬКО С.П., СКРИПНИК Ю.О.

Розглянуто особливості надфонових вимірювань, за допомогою яких виявляється та реєструється сигнал від фізичних чи біологічних об'єктів рівень якого значно слабкіший, ніж власні шуми вимірювальної апаратури. Порівнюються три методи вимірювання: компенсаційний, кореляційний та модуляційний, серед яких модуляційний має найнижчий флюктуаційний поріг чутливості. Аналізується ситуація при вимірюванні нерівноважного електромагнітного випромінювання людини на фоні інтенсивнішого радіотеплового. Описано новий метод вимірювання "живого" випромінювання, заснований на порівнянні загального випромінювання людини з радіотепловим випромінюванням, здійснюваного за допомогою спеціального металокерамічного фільтра. Проведені оцінки радіотеплового випромінювання людини в діапазоні міліметрових хвиль та випромінювання, генерованого її електромагнітним каркасом. Останнє забезпечує оперативний контроль у процесі лікування за допомогою технологій квантової медицини.

НАДФОНОВЫЕ ИЗМЕРЕНИЯ СВЕРХСЛАБЫХ СИГНАЛОВ – ИНСТРУМЕНТ ПОЗНАНИЯ ЖИВОГО (МЕТОДОЛОГИЧЕСКИЕ АСПЕКТЫ)

СИТЬКО С.П., СКРИПНИК Ю.А.

Рассмотрены особенности надфоновых измерений, с помощью которых обнаруживается и регистрируется сигнал от физических или биологических объектов, которые по уровню значительно слабее собственных шумов измерительной аппаратуры. Сравниваются три метода измерения: компенсационный, корреляционный и модуляционный, из которых модуляционный обладает наиболее низким флюктуационным порогом чувствительности. Анализируется ситуация при измерении электромагнитного излучения человека на фоне его более интенсивного радиотеплового. Описан новый метод измерения "живого" излучения, основанный на сравнении общего излучения человека с радиотепловым излучением, которое воспроизводится с помощью специального металлокерамического фильтра. Проведены оценки радиотеплового излучения человека в диапазоне миллиметровых волн и излучения, генерируемого его электромагнитным каркасом. Последнее позволяет осуществлять оперативный контроль в процессе лечения с помощью технологий квантовой медицины.

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