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Chapter 7
Photon emission in multicellular organisms

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Abstract: Ultra-weak photon emission (UPE) from biological systems was first demonstrated, in the early 1960's, by Russian researchers utilizing sensitive photomultiplier equipment. However, already in 1912 a proposal for a morphogenetic radiation field, responsible for regulating biological form was proposed. The main purpose of this chapter is to discuss experimental research that studies the relationship between UPE and morphogenetic aspects, either in development, or stress induced changes followed by recovery processes. Within that context, different biological systems will be briefly described. In plant research, the emphasis is on the relationship between spontaneous UPE and development of seedlings. In the section on UPE recordings in animals, we focus the description on the relation between UPE and cancer development. In research using cell systems, the relationship between UPE and cultured tumor cells, with different degree of differentiation is discussed. This provides information on the coupling of UPE to biological structure and the altered growth properties of tumor cells compared to normal cells. In the last part of the chapter the focus is on studies in human biology, in particular in relation to disease and (healthy) lifestyle.

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1. Introduction

The assumption of (light) radiation from biological systems 100 years ago was not completely unexpected. It was, at that time, part of mainstream developments in biology. Biology, as an independent science, was focusing at the "program for the formation of the form" (Driesch, 1911). This program is the core of several disciplines: developmental biology, regeneration biology, and tumor biology. They demonstrate the process of unfolding the form, the restoration of the form after severe damage, and the malfunctioning of the program, respectively. The "program" is more than a blueprint for the ultimate goal; it also includes the instructions for using the blueprint. With respect to the instructions to renew the body, one immediately recognizes the importance of the "program" for understanding disease and the healing process. It was the discussion on the organization of the living state's form that led in the early 1900's to the question where to look for the essence of the "program": at the matter or at the carrier of the matter.

In Driesch's view, based on early systems theory, the carrier of the matter did not correspond with a purely biochemical approach. Something was lacking in the biochemical approach. Metabolism was about energy and rates. Positions (and the form aspects) were addressed with scalars, vectors and boundaries. These forces are not properties of the molecules themselves. This mystery was increasingly recognized within the framework of living systems theory that accepted the fact that a field of organization with properties specific to the totality of the form cannot be explained solely on molecular grounds (system's particles) (Driesch, 1911). In searching for another, non-mechanical (non-particle) nature of the "program" that determines the formation of the form, an alternative regulatory principle evolved: a morphogenetic (universal biological light) radiation field, the predecessor of the biophoton field. Alexander Gawrilowich Gurwitsch (1912) considered a radiation process as a possible non-mechanical deterministic principle (Gurwitsch, 1912). In his 1912 paper "Die Vererbung als Verwirklichungsvorgang ("Heredity as a Process of Realization"), the notion of the field as applied to biological morphogenesis was defined as elements simultaneously being subject to a single morphogenetic factor**.** This notion was opposite to the alternative conception that considered the morphogenesis as a result of interactions between elements. According to Gurwitsch's morphogenetic field theory, behaviour of both individual cells and rudimentary organs is controlled by a field of forces common to all elements of an embryo. It is presently understood that the field regulates the behaviour of individual cells in developing and regenerating (healing) organisms, routes their movements, controls their division and differentiation, and evolves itself with growth. Initially, Gurwitsch was cautious not specifying the physical nature and initial sources of the field but finally – in 1923 – performed "the"

crucial onion experiment demonstrating the role of UV radiation in mitosis (Gurwitsch, 1923).

It took a long time, until the early 1960's, before Russian researchers were able to detect and confirm – without any doubt – ultra-weak photon emission (UPE) from biological systems utilizing sensitive photomultiplier equipment. It took until the early 1970's, outside the USSR, to study ultra-weak photon emission from biological organisms. The research finally began providing experimental data from three groups spread over the world, namely in Japan (Inaba), Australia (Quickenden) and Poland (Slawinski) and later being followed by teams in Germany (Popp) and the USA (Chance). In 1980, this resulted in a worldwide growth of research addressing ultra-weak photon emission. This does not mean that the 1912 proposal of a morphogenetic radiation field for regulating the biological form was accepted. In fact, the "informative" aspect of the radiation field in the original idea was forgotten. This was probably due to the long duration of physical device development as well as the predominantly biochemical interest of researchers. Therefore, at the end of these developments, the main question was whether this radiation plays a field organizational role, setting into motion development as well as disturbances such as disease and concomitant healing or malfunctioning in tumor formation.

A first step in finding evidence is to study the relationship between the ultra-weak photon emission and morphogenetic aspects, either in development, or stress-induced changes followed by recovery processes, or in tumor development. The purpose of this chapter is essentially the search for these relationships. In this line, this chapter brings together pertinent examples from plant, animal and human biology. However, first, the question is asked how to characterize the photon emission properties of the living organism.

2. The photon storage phenomenon

Since the time that Presman published his work on "Electromagnetic Fields and Life" (1970), it became evident that biological systems not only emit electromagnetic waves but also respond to radiation from extremely slow fluctuations up to the extremely rapid short waves in the UV region (Presman, 1970). In 1974, Cilento postulated the existence of a new type of coupled reaction in biology. The postulate was based on simultaneous occurrence of biochemiluminescence and biophotochemical reactions as well as the occurrence of excited electronic states in dark biological processes (photobiochemistry without light) (Cilento, 1974). Effective intracellular photon trapping is expected to influence metabolic and cellular events (Cilento, 1982). It is strongly analogous to the coupling of reactions that produce and utilize chemical compounds such as ATP or NAD(H) in metabolic pathways using efficient key enzyme regulations. In the course of this energy flow,

numerous chemical reactions of diverse type take place. For different states of organization, this should indicate not only a shift in energy flow patterns, but also in the coupling of biochemiluminescence and biophotochemical reactions.

Following the above view, the working hypothesis was built that measuring *spontaneous emission* of photons provides information about the organism's photon field properties (e.g., photon count distribution) and that the actual number of photons trapped is additional information presumably about the physiological status of an organism. Since the capacity of cells to store photon energy is an intrinsic part of the above hypothesis, it was**,** furthermore**,** suggested to fill up the (presumed) photon stores by artificially illuminating the cells. Suppose that photons are trapped, the properties of the trapping mechanism(s) are reflected by the delayed emission. Precise analysis of the post irradiation photon emission should demonstrate the photon storage characteristics of the biological system. Especially for this latter method of measuring so-called *delayed luminescence* (DL), i.e. for the registration of light-induced photon emission, a double shutter system is needed, which was initially constructed by Ruth in the late 1970 in the laboratory of the Popp group (Ruth, 1979). It works such as that after excitation, a shutter between light source and sample is rapidly closed, whereas, a second shutter between sample and the photomultiplier tube is almost immediately opened. The time between closing the first and opening the second shutter was usually about 100 milliseconds (ms), meaning that recording of delayed photon emission begins 100 ms after the end of illumination.

3. Biophoton emission from plants

The relationship between spontaneous ultra-weak photon emission (UPE) and development in plants has been studied utilizing seedlings of barley (*Hordeum vulgare L.*). As early stages of seedling growth do not need light (most seedlings can grow in darkness inside soil for days), studies on seedlings can reveal changes in photon emission properties during development.

The UPE of seedlings during germination has been recorded either as two-dimensional images (Kobayashi et al., 1997; Bao, 1998) or as curves of intensity estimated with photomultiplier tubes (PMT) (Chen et al., 2003; Yan, 2005), together delivering complementary results. While a two-dimensional image is able to give spatial information and emission intensity distributions of the subject under study, our interest was rather on the evaluation of temporal aspects of photon emission for which the use of PMT is the proper method. Figure 1 shows the temporal UPE (i.e., spontaneous photon emission) pattern registered by PMT of 10 barley seeds during germination.

Immediately after the addition of water to seeds, the photon emission was rather high and then dropped fast in the first half day. Then, the emission turned to increase in the second half of the first day. After that, the UPE rises almost continuously till the end of the experiment because of the exhaustion of the available water for the seedlings in the closed dark chamber. It is interesting to see that there are several peaks in the rising UPE curve of the growing seedlings. The time difference between two of successive peaks is about 1 day, suggesting that even in a dark environment, the circadian rhythm exists in seedlings (see arrows in figure 1). The decreasing emission in the first half-day was observed in living seeds as well as in dead seeds (Yan, 2005). It corresponds with chemical or physical changes of the dry nutrients (starch, protein) during their interactions with water. The following increase in UPE, however, corresponds with growth of seedlings and is linked to cell metabolism. This has been demonstrated by sequentially blowing oxygen and CO_2 gas into the dark chamber where the seedlings were growing. The UPE start dropping immediately when the CO_2 influx begins.

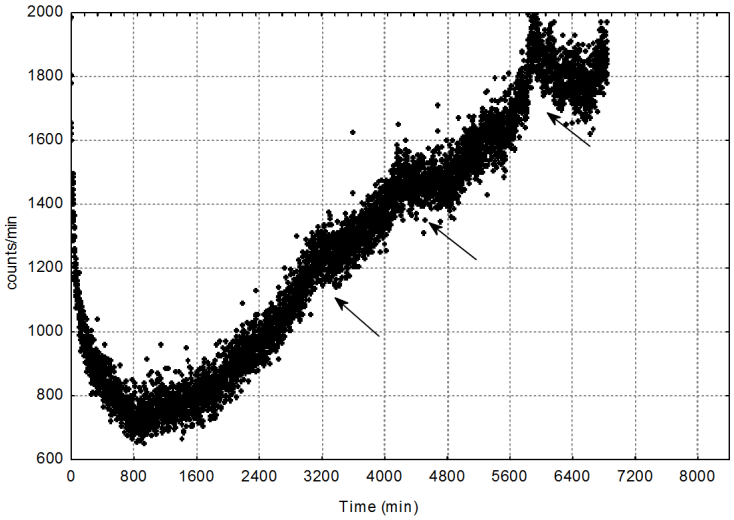

Figure 1. The UPE of 10 successfully germinating barley seeds. The 10 barley seeds were placed in the dark chamber after the addition of 1ml (distilled) water where they began to grow. The UPE (in counts per min; Y-axis) of the seeds and the seedlings in the dark chamber was registered continuously. The arrows indicate peaks in the rising UPE curve suggesting a circadian rhythm. The figure was taken from the dissertation of Y. Yan (2002); copyright Y. Yan.

When the CO_2 influx is stopped and air is blown into the chamber, the UPE jumps high. The data led to two conclusions: (1) they demonstrate that photon emission intensity is related to development, and (2) that oxygen is necessary for photon emission.

In the process of plant development, the appearance of green leaves is associated with extremely high efficiency in photochemistry based on the properties of chlorophyll. Similarly, green plant tissues have been also recognized as emitters after radiation. They show intensive, decreasing, but long-lasting UPE in studies wherein these organisms (after illumination) were placed in the dark chamber in front of a photomultiplier. This light-induced photon emission of green plants was first reported in 1951 (Strehler and Arnold, 1951). In fresh leaves as compared to some days old leaves, the decay commonly shows a particular pattern (Figure 2a)**:** a drop in emissions in the first minute, then a rise for minutes long to a relative maximum and after that a drop again until it reaches a relative constant level (Bertsch and Azzi, 1965; Schmidt and Senger, 1987; Yan et al., 2005). This pattern is assumed to be related to physiology because in leaves measured three days after harvest, the amount of photons emitted at the very beginning was already much lower and, further, the UPE curve showed a continuous decaying without any trace of a relative maximum (Figure 2b).

In another study the relation between photon emission and the intactness of the biological structure was assessed comparing emission patterns (after illumination) from a whole leaf with patterns of homogenates of leaves, isolated chloroplasts and filtered homogenates of leaves.

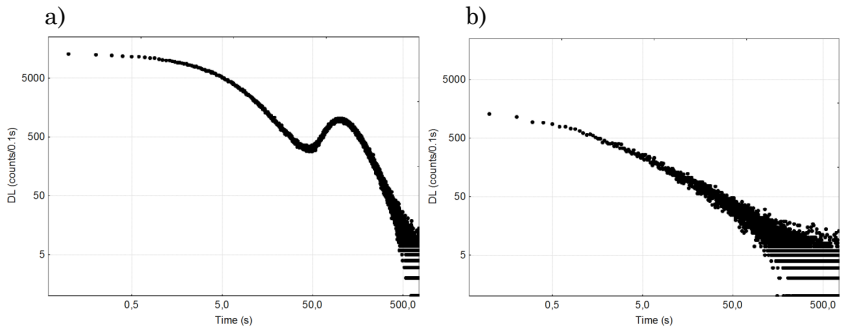

Figure 2. The induced photon emission patterns of a leaf after the illumination by 780nm LED: a) fresh leaf demonstrating an early drop in emission, then a rise to a relative maximum and after that a drop again. b) three days after harvest when the relative maximum had disappeared completely. Note that the X- and Y axis represents a logarithmic time scale. The UPE on the Y-axis is presented in counts per 0.1 s. The figure was taken from the dissertation of Y. Yan (2002); copyright Y. Yan.

These data showed that in whole leaves a characteristic emission with the above mentioned oscillation,(i.e. the temporal minimum and maximum) was observed, while homogenates showed a decay curve without oscillation. Even though isolated chloroplasts display delayed luminescence, they do so without oscillation. A filtered homogenate shows no more light induced delayed luminescence at all, although it contains a lot of chlorophyll and other molecular components of chloroplasts. Together, these findings demonstrate a relationship between DL oscillation and the integrity of leaf tissue suggesting that the emission originates mainly from the photosystems (PS) in the thylakoid membrane of the chloroplasts (Schmidt and Senger, 1987; Yan et al., 2005; Hideg et al., 1991). Such data are the basis for the development of UPE markers to estimate the integrity and probably the quality of the plant.

4. Biophoton emission recordings in animals

The body of an animal or human operates as a society whose individual members are cells. The cells reproduce by dividing themselves (cell division), while the anatomical organization of the adult body remains stable over time. In this society, each cell behaves in a social manner: dividing, differentiating, or dying as needed for the good of the organism. In contrast, cancer does not obey these boundary laws of cells in healthy tissues. Cancer cells encroach imperialistically upon neighbor cells weakening the organism the more they grow. Hence, the major interest in tumor development deals with two aspects: the tumor itself and the influence of the tumor on its bearer. In particular the latter aspect is strongly related to tumor growth and stress upon the organism. The early interest in animal spontaneous photon emission has therefore focused on organs of tumor-bearing animals.

Do tumor-bearing animals show increased UPE in other parts than just the tumor of the organism? In a series of well controlled studies several types of tumor cells (Ehrlich ascites tumor cells, fibrosarcoma cells and adenocarcinoma cells) were injected in mice at locations (subcutaneous or intraperitoneal) at a distance from liver (Boveris et al., 1985). The data gave evidence that spontaneous mouse liver UPE was increased in the early phase after injection of tumor cells compared to controls. The researchers concluded that the liver of tumor-bearing animals is subjected, during the early phase after tumor transplantation, to an oxidative stress with increased levels of peroxyl radicals, which are responsible for the increased UPE in vivo. Another study (Inaba et al., 1982) described an increase UPE in blood samples from humans with carcinomas.

In a study using two-dimensional imaging and photon counting of ultra-weak light emission from transplanted bladder cancer, attention was focused on the comparison of the cancer with the surrounding tissue

when the bladder cancer was transplanted into the feet of nude mice (Amano et al., 1990; 1995). By utilizing two-dimensional imaging, the growing cancer can be specifically distinguished: increased photon emission was observed in the implanted tumor region (Amano et al., 1995). In the early stages of development, tumors gradually disrupt the organizational stability, thereby disrupting normal function of the afflicted tissue. In this early phase changes in interactions occur prior to necrosis, hemorrhage, leukocyte infiltration or crusta formation. It suggested that increased emission corresponded to the increased division activity of the tumor cells. Other studies confirmed that, ultra-weak photon intensity from different transplanted malignant tumors was distinctly higher than was recorded for normal tissue (Amano et al., 1995; Kim et al., 2005; Shimizu et al., 1973). More recently, ultra-weak photon detection was reported from tumors transplanted in mice utilizing a highly sensitive and ultra-low-noise charge-coupled device (CCD) camera system. In addition, a procedure for whole body scanning of mice was developed utilizing a small, mobile and sensitive photomultiplier tube (PMT) operated at room temperature in a dark box (Takeda et al., 2004). These investigations focused on mice that were transplanted with ovarian cancer cells. All data confirmed the increased photon emission in disregulated tumor-bearing tissues. It leads to the conclusion that not only cells with a high division potential demonstrate increased photon emission, but equally well that this detection method may be developed into a diagnostic tool.

In animals, the question has also been asked whether ultra-weak photon emission is oxygen dependent. For tumor-bearing tissues, such study is not available. However, an answer comes from two-dimensional imaging of the biophoton emission from a rat's brain, detected in vivo over the skull. Kobayashi and colleagues (Kobayashi et al., 1999; Kobayashi, 2005) demonstrated that brain photon emission was strongly decreased in the absence of O_2, i.e., under ischemic conditions. Additionally, they simultaneously measured photon emission and electroencephalographic (EEG) activity, demonstrating a correlation between photon emission intensity and the theta wave component of the EEG power spectra. The decrease of photon emission in ischemia makes the interpretation of the tumor observations more complicated. Thus, it is well known that tumor cells have a decreased respiration and instead an increased fermentation (Weber, 1983). It may be suggested that tumors are detectable in early stages only, but this needs further study.

5. Photon emission from isolated tumor cells

Similar to plant tissues and cells, the animal cells also demonstrate the property of a decreasing UPE when recording starts immediately after illumination. This allows the measurement of intracellular photon trapping and its relationship with alterations in metabolic and organizational states. This relationship was studied using cultured tumor cells with different degree of differentiation. It can give information about the coupling of biophoton emission to biological structure and the altered growth properties of tumor cells compared to normal cells. The studies began with the establishment of the molecular correlation concept in *"in vitro"* cultured hepatoma cell lines in the early 1970's by Van Wijk and colleagues. The molecular correlation concept is one of the major concepts in cancer research (Weber and Lea, 1967). Using many transplantable hepatomas (tumors of the liver) it was shown that the biochemical parameters of alterations were the result of a reprogramming of gene expression that was both qualitative and quantitative. It made it possible to pinpoint the reprogramming of gene expression conferred to cancer cells, including the strict reverse relationship between differentiated functions and growth rate. A study of the molecular correlation concept for in vitro liver and hepatoma cells could provide a model system of different states of tumor development that could then be used to study photon emission characteristics. Four hepatoma cell lines isolated in the late 1960's were used for comparative biochemical studies. Those cell lines are commonly named H35 (Pitot et al., 1964), HTC (Thompson et al., 1966), MH_1C_1 (Richardson et al., 1969) and RLC (Gerschenson et al., 1970; Oshiro et al., 1972). They were studied for their degree of differentiation as systematically evaluated at the level of cell morphology and functioning, including sensitivity for hormonal regulation (Van Wijk et al., 1972a; 1972b; 1972c; 1974), ultrastructure of the cytoplasm, mitochondrial volume and structure (Volman, 1978; Volman and Van Wijk, 1980), glycolytic and gluconeogenic functions and (iso-) enzyme activities (Schamhart et al., 1979), growth and division potential (Van Wijk et al., 1973; Wicks et al., 1973a; 1973b). The series of rat hepatoma cell lines definitively illustrated the "molecular correlation concept" at the level of cells "in vitro". The liver characteristics partially persisted in a coordinated manner in the well-differentiated hepatoma cells H35 and MH_1C_1, whereas in the poorly differentiated cell lines HTC and RLC the differentiation characteristics were lost.

These hepatoma cell types and the liver parental cell, thus, were used to study the relationship between the state of differentiation and the photon storage capacity. In 1983, a long-term cooperation between the research groups of Popp (Kaiserslautern, Germany) and Van Wijk (Utrecht, The Netherlands) began. Van Wijk and colleagues used three types of rat liver

cells: from fully differentiated rat liver cells to very poorly differentiated (HTC) rat hepatoma cells with well-differentiated (H35) rat hepatoma cells as an example of an intermediate state differentiation. The comparative studies, suggested that light-induced delayed photon emission (reflecting the photon storage capacity) differed between cell types (Schamhart and Van Wijk, 1987; Van Wijk and Schamhart, 1988; Van Wijk et al., 1990; Van Wijk and Van Aken, 1991; 1992). To summarize the data: liver cells re-emit low numbers of photons at a slow rate, while poorly-differentiated HTC hepatoma cells re-emit high number of photons with a fast speed. The well-differentiated H35 hepatoma cells have intermediate properties. The data correspond with the view that the coupling of biochemiluminescence and biophotochemical reactions fits the molecular correlation concept of tumor development. The data also confirm the photon storage model as proposed by Popp: According to this model (which was initially described in terms of a resonator cavity), a high quality resonant system loses only a small amount of its energy (photons) per unit time, while a low quality system (due to the malfunction of the feedbacks) will give a larger response to the (light) stimulus (Nagl and Popp 1983; Popp et al., 1981).

6. Biophoton emission recording in humans

The last example of studies on the relationship between the ultra-weak photon emission and morphogenetic aspects focuses on studies in human biology, in particular in relation to disease and (healthy) lifestyle. First of all this requires the measurement of human body biophoton emission. Secondly, it requires studies in which human subjects have been distinguished into well-defined life styles or diseases.

In the 1970's, human biophoton emission research was primarily focused on photon emission of specific human body fluids. Research on human body photon emission started in 1979 (Dobrin et al., 1979). A special project on biophoton emission, the "Inaba Biophoton Project" started in Japan in 1986. The project was funded by the Exploratory Research for Advanced Technology (ERATO), a subsidiary of the Research Development Corporation of Japan (presently, Japan Science and Technology Corporation). Human photon emission was hypothesised to reflect the physiology of the human being. This led to medical diagnostic research utilizing biophoton emission (Inaba, 1988; Swinbanks, 1986). Several studies suggest that the intensity of photon emission changes in a state of disease. Japanese studies of the two-dimensional pattern from the index and middle finger indicated that intensities could be used to differentiate hypothyroidism, a lower state of metabolic activity (Usa et al., 1991; 1994; Usa and Inaba, 1995). Ultra-weak photon emission in patients with hyperthyroidism was less intense than normal. The lower emission was also found in patients whose thyroid glands

had been removed. In Germany, Popp and co-workers pioneered since 1993 in human biophoton emission research, utilizing a cooled system with a detector head hanging from rails that could be positioned over any part of a subject. The device was utilized to record emission from 80 healthy and diseased subjects over various body areas. The study confirmed differences in emission between subjects as well as between body locations (Cohen and Popp, 1997a). However, only a few anatomic sites were recorded for each subject and a systematic measurement schedule was not followed. Another study reported on several multiple sclerosis patients who emitted more photons than ordinary healthy subjects (Cohen and Popp, 1997a; 1997b; 2003). In this study, the authors introduced a second parameter for disease, *e.g.*, percentage of difference in emission between left and right hand. They suggested that in certain diseases left-right symmetry was broken. In a South Korean study, left-right symmetry of photon emission from the palm and the dorsum of the hands of hemiparesis patients were compared with similar data from the hands of healthy subjects. The variation in left-right symmetry among healthy subjects was not large. In hemiparesis patients though, the left and right differences were reported very large in both for the palm and dorsum of the hand (Jung et al., 2003).

To initiate systematic body research for the research on the relationship between stress and photon emission in humans, Van Wijk and Van Wijk (2004; 2005a) described a protocol for multi-site recording of subjects. Anatomic sites were selected such that the distribution in photon emission could be studied as right-left symmetry, dorsal-ventral symmetry, and the ratio between the central part of the body and extremities. Although data again demonstrated the variability in patterns between subjects, some generic features were observed: a) the overall intensity of photon counts over the body was lower in the morning than in the afternoon, b) the thorax-abdomen region emits the lowest but most constant emission, and c) the upper extremities and the head region emit the highest levels and increase during the day. The data suggested that a "common" human biophoton emission pattern exists in addition to individual emission patterns and dynamics. This spatial distribution of human ultra-weak photon emission and its dynamics was confirmed by utilizing a highly sensitive charge-coupled device (CCD) imaging system (Kobayashi, 2003; 2005; Van Wijk et al., 2006a; 2006b; Kobayashi et al., 2009).

The mounting evidence indicating that human photon emission can be reliably measured and may be different in some human pathology (Van Wijk et al., 2008) led to an increased interest in the ultra-weak photon emission in relation to lifestyle. It is generally accepted that meditation, if practiced for a long time, induces a greater state of self-awareness and inner calm in its practitioners. The resulting reduction of stress may have prophylactic and therapeutic health benefits. The hypothesis suggesting a

possible link between meditation and its therapeutic effect had stimulated considerable curiosity in the scientific community. The measurement of serum lipid peroxide levels in plasma indicated lower lipid peroxide levels in practitioners of meditation (Schneider et al., 1998; Kim et al., 2005; Yadav et al., 2005). Ultra-weak photon emission studies focused on long-term practitioners of meditation. The first studies utilized the multi-site recording system (Van Wijk and Van Wijk, 2005a). The comparison between practitioners of meditation and subjects without experience in meditation indicated intensity discrimination in emission (Van Wijk et al., 2006). A follow up study examined the ultra-weak photon emission from the hands of three groups of subjects: control group having no experience in meditation, TM group practicing Transcendental meditation, and a different group practicing a form of meditation other than TM (OTM). Each group consisted of 20 healthy, non-smoking subjects. Data demonstrated that the intensity of ultra-weak photon emission by subjects of both meditation groups is lower by 15–33% for the TM group and 4–15% for the OTM group compared to the control group. All subjects demonstrated a high degree of symmetry (Van Wijk et al., 2008a). Additionally, the photon signal was described according to a quantum optical approach utilizing four parameters ($|\alpha|$, φ, r, θ) that determine the signal (Van Wijk et al., 2008b). Both the squeezed state parameters and asymmetries suggest that the control group is different from both meditation groups. The difference between TM and control group is more than that between OTM and control group. The data support the conclusion that reduced stress experience in human subjects does correspond with a change in photon emission parameters.

Like in other studies on spontaneous photon emission, attention was paid to the role of oxygen in human photon emission. In different types of experiments the effect of hypoxia on photon emission was investigated. A tourniquet was placed around the upper arm to depress the supply of oxygen and nutrients to the hand. Photon emission of the hand was recorded during periods of increasing degree of tourniquet tightness. Data demonstrate that photon emission progressively decreased during blood flow limitation (Yang et al., 2004; Van Wijk and Van Wijk, 2005b; Scholkmann et al., 2013). Direct exposure of the hand to oxygen deprivation also resulted in some decrease of photon emission (Nakamura and Hiramatsu, 2005). Apparently, the generation of photons emitted from the hand is due to both, interior sources and the skin itself.

7. Conclusion

The examples presented in this chapter cover a multitude of situations and organisms demonstrating that the organization of the living state corresponds with photon emission characteristics of the organism. Examples are found in plant, animal and human biology, but also in cell biology. Even though this research can be qualified as correlative research, many of the results gave evidence for implicit hypothesis as there was the parallelism between physiological reactions and UPE or the light store capacity in biological material. Such research, however, is of large importance in approaching the morphogenetic field theory. According to this field theory, the behaviour of both, the individual cells and recovery (or repair) processes in healing are controlled by the field. Presently, it is the task to find at the organismal level a model in which an unbalanced condition can be healed by interfering exclusively with the biophoton field. We have suggested that such interference may be brought about by extremely low light therapy procedures (Tafur et al., 2010). It is without doubt that Low Intensity Laser Therapy (LILT) is able to result in wound healing etc.

Our studies resulted in the development of procedures to analyze the photon signal. This led to the hypothesis that the analysis of the "language" in the emitted photon signal has information about the state of health and disease.

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