CONTROL DYNAMICS OF THE EMMITED PHOTONS IN THE BIOLOGICAL MEDIA

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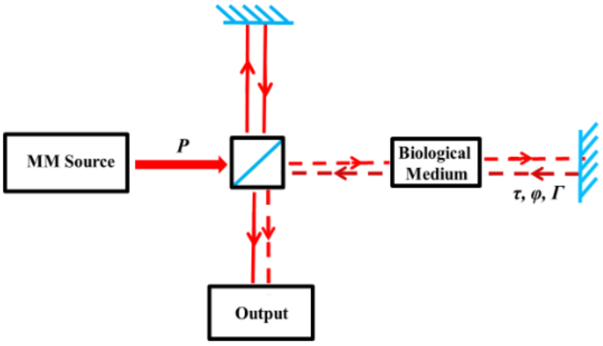
Recently, the influence of electromagnetic fields on the living matter has become an attractive goal for modern biomedicine [1],[2]. The human body is exposed daily to the radiation of various types of electromagnetic waves through modern technologies, which are extremely widespread in everyday life. The effects produced by these radiations can destroy the body's defense and functional systems. However, some classes of electromagnetic waves, e.g., millimeter waves (MM) and terahertz (THZ) can produce constructive therapeutical effects [3].

The theoretical model describing the evolution of photons and phonons generated by the biological media was discussed in our previous papers [4]. Figure 1 shows the scheme of irradiation of the biological environment by MM wave source, whose profile is described by a function with sinusoidal modulated pump power: $P = P_0(1 + m(cos2\pi\omega t))$, where m is the modulated parameter. The photons emitted by the biological medium are delayed from an external mirror, similar to the model of semiconductor lasers with external feedback. The photons and phonons emitted by the biological medium are described by the system of differential equations



$$\frac{dE_1}{dT} = -\sigma E_1 - (\tilde{\delta} - \widetilde{\omega}_0)E_2 + 2\alpha\tilde{\gamma}A_1 + \alpha\{2\tilde{\gamma}[\delta - (A_1^2 + A_2^2)] - 1\}A_2 + P + \Gamma[cos(\varphi)\,E_1(t-\tau) + sin(\varphi)\,E_2(t-\tau)],$$

$$\frac{dE_2}{dT} = (\tilde{\delta} - \widetilde{\omega}_0)E_1 - \sigma E_2 + 2\alpha\tilde{\gamma}A_2 + -\alpha\{2\tilde{\gamma}[\delta - (A_1^2 + A_2^2)] - 1\}A_1 + \Gamma[cos(\varphi)\,E_2(t-\tau) - sin(\varphi)\,E_1(t-\tau)],$$

$$\frac{dA_1}{dT} = -\alpha E_2 - A_1 - [\delta - \nu(A_1^2 + A_2^2)]A_2,$$

$$\frac{dA_2}{dT} = -\alpha E_1 + [\delta - \nu(A_1^2 + A_2^2)]A_1 - A_2$$

Figure 1. Schematic representation of the setup

We describe the system dynamics in terms of bifurcation diagrams. Figure 2 shows a typical bifurcation diagram, where feedback strength Γ is considered as bifurcation parameter. The diagram shows the dependence of photon number on the feedback strength for maximum and minimum values and for various pump parameters. Each dot represents a peak of the output power. For small values of the optical feedback the system displaces continuous wave and oscillatory regimes. An increase of feedback leads to a period doubling and chaotic behavior.

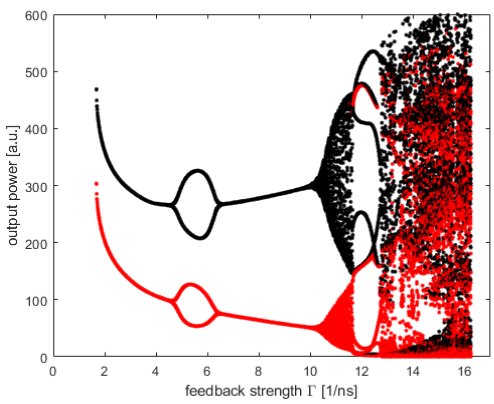


Figure 2. Numerical bifurcation diagram.

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