Water structures, RF and their impacts on biological systems

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Although water is studied more than any other liquid, it still is not completely understood. Reviewing some of the unique characteristics of water and its structure in the presence of ions is a starting point for understanding how bound water molecules shield ions and other biological molecules. The unique behavior of water is largely due to dynamic hydrogen bonded networks that exist when water is in its liquid form. Hydrogen bonds form a random and percolated network and they are weak at room temperature, so the clusters due to hydrogen bonds are constantly forming and breaking up [1]. They form many different structures with very short lifetimes on the order of 10^{-7} seconds. There are many experimental works and simulations which give detailed information about these structures. For example, Ref. [2] suggests that the most stable form of $(H_2O)_6$ is a cage-like structure.

In this paper, the structure of water will be reviewed, including its interaction with its environment of ions and molecules as a function of temperature, electric and magnetic fields (EM). Our exposures to EM in everyday life are increasing, especially as a result of increased usage of cell phones. Many people are concerned about the possibility that the radiation from these phones can cause adverse health effects. [4]. Additionally, there are beginning to be important therapeutic applications of electric fields to bone repair and wound healing. Since our body contains very large amounts of water, it is expected that EM interaction with water will be at least part of the process leading to biological effects. Water being dipolar and having weak hydrogen bonds has potential to be affected by electric and magnetic fields [3]

An objective of this paper will be to bring together some of the material on the structure of water and its interactions with molecules and ions in the presence of electric and magnetic fields at RF frequencies so as to provide a basis for extending our understanding the effects of externally applied fields to biological systems.

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2- Liu, K. et al, “Characterization of a cage form of the water hexamer", Nature vol 381, 6 June 1996
3- http://www.lsbu.ac.uk/water/magnetic.html
4- Beers, G.J., Biological effects of weak electromagnetic fields from 0 Hz to 200 MHz: a survey of the literature with special emphasis on possible magnetic resonance effects
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