

ON THE RELATIONSHIP BETWEEN EXCLUSION ZONES AND COHERENCE DOMAINS IN WATER

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In the first decade of the current century Gerald Pollack and his associates have shown that water adjacent to hydrophilic surfaces (interfacial water) is a new allotropic form of water dynamically different from bulk liquid water. Such water was termed exclusion zone water (EZ-water) because colloid particles and different solutes are excluded from aqueous zones closely adjoining to hydrophilic surfaces on the order of tens and hundreds of microns. Properties of EZ-water imply that it represents a kind of a liquid crystal. One of the most intriguing properties of EZ-water is that near a surface bearing a net negative charge it is negatively charged and near a positively charged surface it is positively charged. The higher is the density of fixed charges on the surface the higher is the thickness of EZ-water [1]. This property of EZ-water contradicts the general law stating that the charges of the same name should repel, while opposite charges should attract each other. Here we suggest an argument allowing to our opinion to resolve this paradox.

A charged surface (e.g., ion-exchange resins, nucleic acids, proteins, etc.) is a solid backbone to which charged chemical residues are covalently bound. Like charges repel each other, but as they are fixed to a matrix and as each charged residue is surrounded by other charges they all have to vibrate. Their collective vibration becomes coherent due to the principle of minimization of energy. Vibration of charges produces an electromagnetic field (EMF) propagating to space surrounding the charged surface. According to conventional “flickering clusters” model of water thickness of hydration water near hydrophilic surfaces should not exceed 1-2 layers, and it does not matter if the charged surface is the source of an oscillatory EMF. However, the situation is different if liquid water is a two phase system as it follows from the application of Quantum Electrodynamics (QED) theory to water and if one of the phases represents ensembles of water molecules, named coherence domains (CDs), oscillating in phase between the ground state and electron excited state. A CD may be also characterized as an extended mesoscopic space region where all molecules oscillate in tune with a self-trapped EMF. Because of thermal noise a substantial part of water molecules loses coherence, and CDs are “suspended” in non-coherent water. It follows from QED theory that the electron excited state involved in the coherent oscillations of water (12,06 eV) corresponds to a CD size of 0.1 microns [2] implying that several millions of water molecules participate in coherent oscillations. The surface of CD is enriched with quasi-free electrons (energy of ionization of water molecules is 12,6 eV). As electrons represent quasi-free charges fixed on the surface of the mesoscopic CD, they should also coherently oscillate for the reasons similar to that described for the charges fixed on the polymeric surface. Thus aqueous CDs represent sources of coherent oscillatory EMFs. If the coherent EMF of the charged surface contacting with water gets into resonance with the coherent CD EMF, the latter will be attracted by the charged surface. As an oscillating CD is approaching the oscillating charged surface the amplitude of the oscillations of a CD is increasing. When the surface is charged negatively, and the EMF produced by it resonates with EMF produced by oscillations of electrons of a CD, protons of water molecules that cannot oscillate with the same frequencies as electrons are ejected from the CD. When this happens, CD water converts into EZ-water. If the surface carries fixed negative charges CD converts into negatively charged EZ-water. The degree of coherence of oscillations of non-compensated electrons of EZ-water fixed to quasi-polymeric aqueous matrix is highest for layers of EZ-water closest to the oscillating charged surface. Accordingly the negative charge density of the layers of water decreases with the increase of their distance from the charged surface. Overall charge density (electrical potential of EZ-water) and the thickness of EZ-water layer depend upon charge density of fixed charges of the polymeric surface. This scenario explains why a *negatively* charged surface is covered with *negatively* charged water: an oscillatory EMF generated by the surface resonates with the oscillatory EMF of CD, the resonance overcomes electrostatic repulsion of like charges since charges oscillating in unison keep together. In the case of positively charged surfaces immersed in water (for example, a polymer to which tertiary amines are covalently bound) oscillating species are protons (nuclei). The mass of a proton is about 2000-fold larger than that of an electron, so the frequency range of positive charges oscillations should lie in a completely different range than the range characteristic for electron (negative charges) oscillations. Thus the parameters (frequencies) of the coherent EMF generated by the positively charged surface are quite different from those characteristic for the negatively charged surface. This coherent EMF will attract the nearby CDs due to the resonance with quasi-free protons of CDs. When CDs approach the surface generating EMF due to oscillations of fixed positive charges quasi-free electrons are ejected from coherently oscillating water (probably in a form of HO⁻ ions) and an oscillating lattice of positively charged quasi-polymeric water stay attached to the vibrating surface.

The concept of the origination of EZ-water described above agrees with all its known properties; it allows explaining why EZ-water forming near a charged surface should have the same sign of charge as the sign of the surface. It follows from this concept that the presence of CDs in liquid water that follows from the application of QED theory to water is the necessary and sufficient condition for the emergence of EZ-water adjacent to surfaces carrying multiple fixed charges when particles with such surfaces contact liquid water.

References

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2. Arani, R., et al. // Int. J. Mod. Phys. B. 1995, v. 9, p. 1813.