Domains Formation Mediated by Electromagnetic Fields in Very Dilute Aqueous Solutions: 3. Quantum Electrodynamic Analyses of Experimental Data on Solutions of Weak Electrolytes and Non-electrolytes

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For a list of abbreviations, see Table 2 on page 92.

(This is the third part of a three-part series.)

Abstract

Molecular associates in very dilute solutions of weak electrolytes or non-electrolytes kept at ambient conditions are studied. Ambient electromagnetic fields affect some of the associates’ types. For concentrations (C) in the range of about $10^{-7} - 10^{-20}$ M, the associates were observed only for solutions with polar solvents, *e.g.*, water, chloroform. At such very low $C$, sizes of these associates reaching tens of micrometers imply that these mainly are composed of solvent molecules. Some associates’ properties are correlated with the bioactivity of the solutions. As discussed in our two preceding publications in this journal’s issue, electromagnetic fields affecting associates entail electrodynamic forces have to be explicitly described. We employ a quantum electrodynamic model for analyzing experimental data pertaining to the associates’ properties and their impact on the solutions physicochemical characteristics. Our analyses show that associates mediated by electromagnetic fields have the typical characteristics predicted by the model. Our analyses clarifies the prerequisites of polar solvents, serial dilutions and vigorous shaking after each dilution step for stabilizing associates in solutions with $C$ below about $10^{-7}$ M. Our analyses provide clues for the domains impact on bio-systems.

Introduction

During the last decade $10^{-7} - 10^{-4}$ m sized molecular associates were observed in polar liquids and their very dilute solutions kept at ambient conditions. For example, in water or chloroform containing non-electrolytic, weak or strong electrolytic solutes, with concentrations (C) in the range of $10^{-7}$ - $10^{-20}$ M. At such ultra low concentrations (ULC), the huge sizes of these associates imply these are mainly composed of sol-
vent molecules. Some of these solutions are bioactive, e.g., these are antioxidants, plant growth regulators, neuromediators. For reviews see Konovalov and Ryzhkina (2014a) and Elia et al. (2015). Stabilization of associates in ULC solutions have been induced by several perturbative techniques, e.g., serial dilutions with vigorous shaking after each dilution step, iterative filtering liquids, iterative agitating liquids with a Nafion membrane. Independent research groups with a wide variety of techniques evidenced presence of the associates. Therefore it can be ruled out that the relevant data is due to measurement errors. As to impurities released by containers, by filters or by membranes, these affect the perturbed liquids but cannot account for their typical properties -- see Elia and Niccoli (2004), Elia et al. (2013, 2015), Yinnon and Liu (2015a,b).

With water, other polar liquids and their solutions playing central roles in many physical, chemical and biological systems, knowledge about the associates' properties and the physics underlying these is important. Analyses of associates in serial diluted vigorously shaken aqueous strong electrolyte solutions (SDVSASES) we presented in the paper preceding this publication in Water journal. For analyses of iterative filtered water or water agitated with a Nafion membrane (so called Iterative Nafionized Water) see Elia et al. (2015), Yinnon and Elia (2013), Yinnon et al. (2015c in press). The foci of our current manuscript are associates in polar liquids' solutions which were serial diluted, vigorously shaken after each dilution step and contain weak or non-electrolytic solutes. We denote these Serial Diluted Vigorously Shaken Polar Liquids of Weak Electrolytes or Non-Electrolytes as SDVSPLwe-ne. Molecular association in ULC SDVSPLwe-ne initially was revealed with calorimetric, electric conductivity (χ) and pH measurements (Elia and Niccoli, 1999, 2000, 2004). Vigorous shaking after each dilution step is a crucial perturbation required for inducing such association. Serially diluting solutions while omitting the vigorous shaking do not lead to molecular association for C below a solute type dependent critical concentration (Ccrit), i.e., these solutions have the customary infinite diluted solutions characteristics. Typically ~10^-10 M < Ccrit < ~10^-6 M. Not all solutes facilitate molecular association in ULC SDVSPLwe-ne (Konovalov, 2013). The required solute attributes are not yet clarified.

The sizes of associates in ULC SDVSPLwe-ne, their electrokinetic potential (ζ-potential) and their impact on the liquid’s dielectric permittivity were first uncovered with dynamic light scattering (DLS), electrophoresis and dielectric titrations (Konovalov et al., 2008; Ryzhkina et al., 2009a). Stabilization of the associates occurs during about 1-18 hours after preparation of SDVSPLwe-ne. For solute type dependent C ranges, correlation was observed between ULC SDVSPLwe-ne’s bioactivity, χ, their associates’ effective hydrodynamic diameter.

SDVSPLwe-ne preparation involves serial decimal or centesimal diluting a “stock” solution. Hitherto, mainly aqueous SDVSPLwe-ne have been studied, but effects of other solvents also was investigated. Aqueous SDVSPLwe-ne are prepared with freshly doubly distilled water or water purified by Simplicity®Water Purification Systems - Millipore, with specific electrical conductivity below 2.5 μS/cm. Dust is removed. Stock solution is analyzed for absence of impurities. Concentration of stock solutions are in the 10^-1 - 10^-3 M range. After each dilution step, SDVSPLwe-ne are vigorously shaken, e.g., with lab dancer shaker, by vertical vortexing or other methods. Plastic or glass vessels are used. Temperature and pressure are kept constant, typically, respectively, at 298 K and about 1 Atmosphere. As controls, the solvent, e.g., water, is serial diluted and shaken after each dilution step, with all experimental parameters identical to those of SDVSPLwe-ne preparation.
and ζ-potential; all these properties non-linear depend on C and are reproducible (Ryzhkina et al., 2009a,b, 2010a,b, 2011a-e, 2012a-d, 2013; Konovalov et al., 2014a-c).

The origins of the physical, chemical, catalytic and bio-active properties of associates in ULC SDVSPLwe-ne are not yet clarified. As to forces underlying the molecular association in ULC SDVSPLwe-ne, electro-dynamic ones play a crucial role. As first demonstrated in 2011 by Konovalov’s group, on storing samples under hypo electro-magnetic conditions, i.e., in a Permalloy container with residual field of 10 nano Tesla, no associates are observable for $10^{-20} < C < C_{\text{thr}}$; a weak electro-magnetic field (EMF) influences the associates for $C_{\text{thr}} < C < 10^{-4}$ M (Ryzhkina et al., 2011d, 2012a, c, 2013; Konovalov, 2013, 2014a-c). The threshold concentration $C_{\text{thr}}$ is solute type dependent, typically $10^{-10} < C_{\text{thr}} < 10^{-6}$ M. These findings signify explaining ULC SDVSPLwe-ne phenomena necessitates electrodynamic theory. The quantum electrodynamic (QED) model for SDVSPLwe-ne proposed by Yinnon and Yinnon (2011) has provided consistent explanations for various phenomena, e.g., SDVSPLwe-ne’s heat of mixing, $\chi$ and their dependence on time and volume (Yinnon and Elia, 2013).

The goals of this paper are: (a) employing the QED model of SDVSPLwe-ne for explaining recently observed (and to the best of our knowledge yet unexplained) characteristics of the various associate types present in these liquids; (b) elucidating the associates’ impacts on these liquids’ properties, e.g., their dielectric permittivity, spectra and bioactivity. This paper is the third of a series on associates in serial diluted solutions printed in this journal’s issue. In the first paper of the series, we presented a summary of the main QED theory aspects of polar liquids in general, and water in particular, relevant to serial diluted solutions. Hitherto this theory mainly is employed for explaining special phenomena and therefore readers may be unfamiliar with these aspects. In the second paper: we summarized the model proposed by Yinnon and Yinnon (2011) for serial diluted vigorously shaken aqueous strong electrolyte solutions (SDVSASES), and we showed that the model’s predictions pertaining to the properties of the associates present in these liquids conform to the measured ones. In the current paper, in its Theory section we concisely summarize the SDVSPLwe-ne model proposed by Yinnon and Yinnon (2011). The model is similar to that of SDVSASES, but varies from it in several aspects. For preventing duplication, we will refer to the two preceding papers for detailing and explaining some QED properties of associates in polar liquids. In the Discussion Section we focus on recently reported measured SDVSPLwe-ne properties and show these conform to those predicted by the model. At the end of this section we conjecture possible mechanisms for serial diluted vigorously shaken solutions affecting biosystems. We stress we do not present any new experimental results -- our discussions pertain to previous reported experimental data. A list with abbreviations is presented at the end of this paper.

Theory

Properties of ULC SDVSPLwe-ne containing molecular associates considerably differ from those predicted by the customary theories of equilibrated polar liquids and their ULC solutions. According to the customary theories: below a solute type dependent concentration all solutes solvate; solvated solutes distribute homogenously, move independently and randomly; polar solvent molecules (except solvation shells’ solvent molecules) move randomly; for aqueous solutions, its water molecules (H$_2$O) form flickering hydrogen-bond networks; electromagnetic radiation, serial dilutions or vigorous shaking do not affect ULC solutions (Horne, 1972). These customary mod-
els explicitly include electrostatic forces and assume electrodynamic ones can be treated perturbatively. In contrast, QED theory explicitly includes electrodynamic forces.

QED indicates that EMF interactions with electrolytic solutes, polar solute molecules or with solvent molecules with sufficiently large electric dipole moments may lead to formation of various QED domains types. Formation of the domains occurs only in specific $C$ ranges (including ULC). These ranges depend on solute type. The domains were generally denoted as “CD” -- a shortening for “coherence domains”. CD may agglomerate into supra-domains (supra-CD). Supra-CD are not ensembles of molecules but agglomerates of domains, like domains in liquid crystals. Details of the QED theory of polar liquids and their various hitherto identified CD, their schematic pictures, their properties, the physics underlying CD formation’s dependence on concentration, citations of experimental data verifying aforementioned and the reason underlying the name “coherence domain” are presented in the first paper of this series (Yinnon and Liu, 2015a).

**Coherence domains** -- The CD types relevant to the SDVSPL we-ne model include $\text{CD}_{\text{plasma}}$, $\text{IPD}_{\text{plasma}}$, $\text{CD}_{\text{rot}}$ and $\text{CD}_{\text{elec.}}$. Below we concisely summarize their properties. Some of these vary from those for solutions of strong electrolytes, summarized in Yinnon and Liu (2015b).

- $\text{CD}_{\text{plasma}}$ -- these domains only form when the solvent molecules have a sufficiently strong electric dipole moment. $\text{CD}_{\text{plasma}}$ are composed of few solvated solutes and numerous solvent molecules (Del Giudice et al., 2000). The plasma oscillations of these solvated solutes are coherent. Interactions between the solutes and tetra Herz to mega Herz EMF underlie the coherence. $\text{CD}_{\text{plasma}}$ are not micelles. $\text{CD}_{\text{plasma}}$ are very stable.

  A micelle is an aggregate of surfactant molecules. In aqueous solutions, its molecules’ domains. Energy gained by a solute particle on its incorporation in $\text{CD}_{\text{plasma}}$ amounts to a few eV. Weak electrolytes only organize in $\text{CD}_{\text{plasma}}$ for $C_{\text{IPD}_{\text{plasma}}} < C < C_{\text{CD}_{\text{plasma}}}$. [This is not the case for solutions of strong electrolytes, in which $\text{CD}_{\text{plasma}}$ form at all concentrations above $C_{\text{IPD}_{\text{plasma}}}$]. Solute characteristics determine the transition concentrations $C_{\text{IPD}_{\text{plasma}}}$. Typically: $C_{\text{IPD}_{\text{plasma}}} < 1 \text{M}$ (Del Giudice et al., 2000); $C_{\text{IPD}_{\text{plasma}}}$. $C_{\text{IPD}_{\text{plasma}}}$ is the concentration at which the distance between identical nearest neighbor solutes equals the Debye length. As to non-electrolytes, only those with sufficiently large permanent or by the solvent induced electric dipole moments can organize in $\text{CD}_{\text{plasma}}$. Just as for weak electrolytes this only occurs for $C_{\text{IPD}_{\text{plasma}}} < C < C_{\text{CD}_{\text{plasma}}}$. The diameter of $\text{CD}_{\text{plasma}}$ is of the order of $10^{-6}$ m. It is an inverse function of concentration, *i.e.*, when the concentration decreases, the size of $\text{CD}_{\text{plasma}}$ increases, the number of its solvated solutes diminishes and the number of its solute molecules enhances.

  - $\text{IPD}_{\text{plasma}}$ -- these domains only form when the solvent molecules have a sufficiently strong electric dipole moment. As to solutions of non-electrolytic compounds, $\text{IPD}_{\text{plasma}}$ only form when the solvated solutes have sufficiently strong electric dipole moments. $\text{IPD}_{\text{plasma}}$ formation requires $C$ is below the transition concentration $C_{\text{IPD}_{\text{plasma}}}$. Hydrophilic “head” regions are in contact with surrounding solvent, sequestering their hydrophobic single “tail” regions in the micelle’s centre. The critical concentration of the surfactant molecules above which micelles form and all additional surfactants added to the system go to micelles is denoted critical micelle concentration.

  The Debye length equals the distance beyond which the Coulomb electric field around a solute molecule is at any instant fully screened by all its neighboring molecules.

\[ \text{Debye length} = \frac{\kappa}{C_{\text{IPD}_{\text{plasma}}}} \]

\[ \kappa = \frac{1}{2 \pi d_{\text{D}}} \]
(Yinnon and Yinnon, 2012). IPD$_{\text{plasma}}$ are composed of few solvated solutes and numerous solvent molecules. IPD$_{\text{plasma}}$ are not micelles. The plasma oscillations of the solutes in IPD$_{\text{plasma}}$ are in phase i.e., an IPD$_{\text{plasma}}$ is a special CD -- an In-Phase Domain. Also the plasma oscillations of its solvent molecules are in phase. Interactions between its molecules and tetra Herz to mega Herz EMF underlie all these in phase plasma oscillations. IPD$_{\text{plasma}}$ are crystalline structured. The dipole moments of their solvent molecules are spherical symmetric aligned around their crystalline ordered solvated solutes. IPD$_{\text{plasma}}$ are very stable domains, slightly more stable than CD$_{\text{plasma}}$. On diluting below $C_{\text{trans IPDplasma}}$, CD$_{\text{plasma}}$ transform into IPD$_{\text{plasma}}$, i.e., the coherent plasma oscillations of the domains’ solvated solutes become in phase. The diameter of IPD$_{\text{plasma}}$ equals that of CD$_{\text{plasma}}$ at $C_{\text{trans IPDplasma}}$, i.e., about $10^{-6}$ m. In contrast to the case for CD$_{\text{plasma}}$, the diameter of IPD$_{\text{plasma}}$ does not significantly change with concentration. On diluting solutions below $C_{\text{IPDplasma}}$, the number of IPD$_{\text{plasma}}$ diminishes.

- CD$_{\text{rot}}$ -- these domains only form when the solvent molecules have a sufficiently strong electric dipole moment. These domains are composed of ferroelectric ordered solvent molecules (Del Giudice et al., 1988; Del Giudice and Vitiello, 2006). The molecules constituting CD$_{\text{rot}}$ coherently oscillate between two rotational states. CD$_{\text{rot}}$ formation results from the dipole moments of their molecules interacting with Far Infra Red (FIR) EMF. CD$_{\text{rot}}$ have an electric dipole moment due to the ferroelectric ordering of their solvent molecules. In bulk water and most other polar liquids at ambient conditions CD$_{\text{rot}}$ do not auto-organize. However, immersing objects with sizable asymmetric charge distributions (e.g., macromolecules, hydrophyllic membranes) may induce their formation, resulting in a permanent time dependent polarization. Solute molecules destroy CD$_{\text{rot}}$. Solute and solvent types determine critical $C$ below which CD$_{\text{rot}}$ persist ($C_{\text{CDrot}}^{\text{crit}}$). CD$_{\text{rot}}$’s diameter is of the order of $10^{-4} - 10^{-5}$ m.

- CD$_{\text{elec}}$ -- these domains are composed of electronically excited solvent molecules. Only for water the characteristics of these domains were derived (Arani et al., 1995; Bono et al., 2012). The CD$_{\text{elec}}$ present in water were denoted by CD$_{\text{H2O,elec}}^{\text{H2O}}$. These domains are composed of solvent molecules only. CD$_{\text{H2O,elec}}$ cannot contain solutes. Solvated solutes or aggregates of solutes (e.g., CD$_{\text{plasma}}$ or IPD$_{\text{plasma}}$) locate adjacent to CD$_{\text{H2O,elec}}^{\text{H2O}}$. The H$_2$O constituting CD$_{\text{H2O,elec}}^{\text{H2O}}$ coherently oscillate between their electronic ground $|0\rangle$ state and an excited $|b\rangle$ state. CD$_{\text{H2O,elec}}^{\text{H2O}}$ formation is mediated by ultraviolet (UV) EMF. One electron of an H$_2$O residing in its $|b\rangle$ state is almost free (binding energy of about 0.4 eV). Hence, a CD$_{\text{H2O,elec}}^{\text{H2O}}$ is a pool of $\sim 10^6$ quasi-free electrons located at their boundary, and correspondingly an ensemble of quasi free protons (the partners of the quasi-free electrons). At ambient conditions, in bulk water: the fraction of H$_2$O included in CD$_{\text{H2O,elec}}^{\text{H2O}}$ is about 20 percent; H$_2$O continually adsorb on CD$_{\text{H2O,elec}}^{\text{H2O}}$ while simultaneously H$_2$O desorb, causing a $\sim 10^{-14}$ s timescale flickering landscape. Thus CD$_{\text{H2O,elec}}^{\text{H2O}}$ observation requires fast resolution probes. CD$_{\text{rot}}$, CD$_{\text{plasma}}$, IPD$_{\text{plasma}}$ or other aggregates of solutes may stabilize CD$_{\text{elec}}^{\text{H2O}}$, i.e., reduce their flickering and ease their observation. CD$_{\text{H2O,elec}}^{\text{H2O}}$ and supra-CD$_{\text{rot}}^{\text{H2O,elec}}$ may get encapsulated in CD$_{\text{rot}}$ and supra-CD$_{\text{rot}}$. Such assemblies we denote [supra-CD$_{\text{rot}}^{\text{H2O,elec}}$ <supra-CD$_{\text{H2O,elec}}$>]. The state of H$_2$O belonging to both CD$_{\text{rot}}$ and CD$_{\text{H2O,elec}}^{\text{H2O}}$ is a superposition of the state typifying the H$_2$O constituting CD$_{\text{rot}}$ and the state typifying the H$_2$O constituting CD$_{\text{H2O,elec}}^{\text{H2O}}$. The diameter of CD$_{\text{H2O,elec}}^{\text{H2O}}$ is about $10^{-7}$ m.

To give the reader an intuitive feeling for the relative sizes of the CD$_{\text{rot}}$, CD$_{\text{plasma}}$ and CD$_{\text{H2O,elec}}^{\text{H2O}}$, we note their ratios are similar, re-
spectively, to those of the sun, earth and moon.

**Superfluidic domains** -- CD<sub>rot</sub>, IPD<sub>plasma</sub> and CD<sub>elec</sub><sup>H<sub>2</sub>O</sup> are superfluidic domains, i.e., their molecules do not collide (see Yinnon and Liu, 2015a). CD<sub>plasma</sub> are not superfluidic. The superfluidity of CD has implications for the liquid’s properties, e.g., its electric conductivity.

**Schematic pictures of aqueous solutions according to QED** -- Figure 1 presents schematic pictures of serial diluted aqueous solutions of weak- or non-electrolytic compounds for 10<sup>-20</sup> M<C<1 M. The (a) and (b) series pertain to solutions which, respectively, were not vigorously shaken and those which were vigorously shaken after each dilution step. Figure 1 is similar to the schematic picture of aqueous solutions of strong electrolytes presented in Figure 1 in the preceding paper (Yinnon and Liu, 2015b). The main differences are that in solutions of weak- or non-electrolytic compounds: none or only few solutes solvate for C above C<sub>trans</sub><sup>CDplasma</sup>; solvated solutes only organize in CD<sub>plasma</sub> for C<sub>trans</sub><sup>IPDplasma</sup> <C <C<sub>trans</sub><sup>CDplasma</sup>. Hence Figure 1ia communicates that for concentration above C<sub>trans</sub><sup>CDplasma</sup> the solvated solutes move randomly, i.e., do not organize in CD<sub>plasma</sub>, and aggregates of non-solvated solutes are present. Figure 1 iia shows that for C<sub>trans</sub><sup>IPDplasma</sup> <C <C<sub>trans</sub><sup>CDplasma</sup> solvated solutes organize in CD<sub>plasma</sub> and CD<sub>elec</sub><sup>H<sub>2</sub>O</sup> and supra-CD<sub>elec</sub><sup>H<sub>2</sub>O</sup> are stabilized by CD<sub>plasma</sub>. Figure 1iia and Figure 1iiia exhibit the transition of CD<sub>plasma</sub> into IPD<sub>plasma</sub>. On comparing Figure 1iiia, Figure 1iva and Figure 1v, one discerns that the diameter of IPD<sub>plasma</sub> does not significantly change with concentration. Instead on diluting, the number of IPD<sub>plasma</sub> diminishes. On diluting also the number of non-solvated solutes diminishes. Figures 1 vi-viiia illustrate that in very dilute solutions, IPD<sub>plasma</sub> do not form and all solvated solutes locate randomly.

**SDVSPL<sup>we-ne</sup> model**

Figures 1ib-viiib present a schematic picture of the SDVSPL<sup>we-ne</sup> model proposed by Yinnon and Yinnon (2011), i.e., the structure of SDVSPL<sup>we-ne</sup> for different concentration ranges. Its details we discuss in the following paragraphs. We emphasize that the model only holds when the solvent molecules have a sufficiently strong electric dipole moment.

i. For C above the transition concentration C<sub>trans</sub><sup>CDplasma</sup>, few or none weak- or non-electrolytic solutes solvate. Most solutes do not solvate. The few solvated solutes move randomly -- see Figure 1ib. Aggregates of unsolvated solutes may stabilize CD<sub>elec</sub><sup>H<sub>2</sub>O</sup> and may form supra-CD<sub>elec</sub><sup>H<sub>2</sub>O</sup>. For C in between the transitions concentrations, i.e., C<sub>trans</sub><sup>IPDplasma</sup> <C <C<sub>trans</sub><sup>CDplasma</sup>, solvated solutes organizing in CD<sub>plasma</sub> enhances (drives) the solvation process. At these C, part of the solvated weak electrolytes organize in CD<sub>plasma</sub> and supra-CD<sub>plasma</sub> (see Figure 1iib). As to solvated non-electrolytic compounds, only those having a sufficiently large electric dipole moment organize in such domains. CD<sub>plasma</sub> and supra-CD<sub>plasma</sub> may stabilize CD<sub>elec</sub><sup>H<sub>2</sub>O</sup> and supra-CD<sub>elec</sub><sup>H<sub>2</sub>O</sup>. The aforesaid holds independent of the solutions’ preparation procedure, i.e., not just for SDVSPL<sup>we-ne</sup> but also for solutions prepared without serial dilutions or vigorous shaking. Serial dilutions or vigorous shaking affect CD<sub>plasma</sub>, mainly causing their breakup. However, after perturbations are over CD<sub>plasma</sub> reform, as illustrated in Figure 1iib.

ii. At C~ C<sub>trans</sub><sup>IPDplasma</sup>, CD<sub>plasma</sub> containing weak electrolytes transform into IPD<sub>plasma</sub> (see Figs.1iib-iiib). The transformation modifies electric conductivity and its dependence on C and time, because IPD<sub>plasma</sub> are superfluidic and crystalline structured while CD<sub>plasma</sub> are not superfluidic. As to solvated non-electrolytes, only those having a sufficiently large electric dipole moment organize in IPD<sub>plasma</sub>. Differences between the transi-
**Figure 1:** This figure presents a schematic picture of serial diluted solutions of weak electrolytes or non-electrolytic compounds. The top row (a) and bottom row (b) series pertain to solutions which, respectively, were not vigorously shaken and those which were vigorously shaken after each dilutions step. Figure ia illustrates that for $C > C_{\text{trans}}^{\text{CDplasma}}$, all solvated solutes move randomly, i.e., do not organize in $\text{CD}_{\text{plasma}}$. The tiny blue balls represent randomly moving $\approx 10^{-9} - 10^{-8}$ m solvated solutes. The irregular shaped bunches of black hexagons represent aggregates of non-solvated solutes. Figure iia illustrates that on dilution below $C_{\text{trans}}^{\text{CDplasma}}$, solvated solutes organize in $\text{CD}_{\text{plasma}}$ (symbolized with purple-blue colored balls). The yellow-brown balls and their agglomerates represent, respectively, $\approx 10^{-7}$ m $\text{CD}_{\text{elec}}^\text{H}_2\text{O}$ and supra-$\text{CD}_{\text{elec}}^\text{H}_2\text{O}$ stabilized by $\text{CD}_{\text{plasma}}$. Figures iia and iia illustrate the transformation of $\text{CD}_{\text{plasma}}$ into $\text{IPD}_{\text{plasma}}$ at $C \sim C_{\text{trans}}^{\text{IPDplasma}}$. Figures ia-iiia illustrate that on dilution the diameter of $\text{IPD}_{\text{plasma}}$ does not change, but the number of $\text{IPD}_{\text{plasma}}$ diminishes. Figures via-viiia illustrate that below a certain concentration there are insufficient solutes to form $\text{IPD}_{\text{plasma}}$. The concentration below which no $\text{IPD}_{\text{plasma}}$ form has yet not been theoretically derived. Figures via-viiia illustrate that whenever there are too few solutes to form $\text{IPD}_{\text{plasma}}$, the solution has the characteristics predicted by the customary models, i.e., all solvated solutes move randomly and their number diminishes on dilution.

In the Figure 1b series, the blue zigzag curves symbolize that shaking excites or cracks domains and aggregates. Figure iib illustrates that excitations or cracking does not significantly alter the internal structure of $\text{CD}_{\text{plasma}}$, which just as in Figure iia are represented with purple-blue colored balls. Figures iib and iib illustrate the transition from $\text{CD}_{\text{plasma}}$ to $\text{IPD}_{\text{plasma}}$, with the latter pictured as blue-crystalline balls just as in Figure iia. Figures iib and iib illustrate that shaking excites or breaks up $\text{IPD}_{\text{plasma}}$. The excited or broken $\text{IPD}_{\text{plasma}}$ pieces, which in the text we denoted electric dipole aggregates (EDA$_{\text{IPDplasma}}$), are pictured as irregular shaped aggregates in (iib). Their aligned black arrows orderings symbolize EDA$_{\text{IPDplasma}}$’s distorted ferroelectric $\text{H}_2\text{O}$ orderings. The purple arrow in the EDA$_{\text{IPDplasma}}$ symbolizes these domains’ dipole moments. Figures ivb and vb illustrate that on diluting below a solute type dependent critical concentration ($C_{\text{crit}}^{\text{CDrot}}$) $\text{CD}_{\text{rot}}$ get stabilized by EDA$_{\text{IPDplasma}}$, i.e., the irregular shaped EDA$_{\text{IPDplasma}}$ are located within the elongated ovals representing $\text{CD}_{\text{rot}}$. The dark blue arrows symbolize the dipole moment of $\text{CD}_{\text{rot}}$. Figure vib shows that vigorous shaking excites or breaks up $\text{CD}_{\text{rot}}$, thus...
creating $\text{EDA}^{\text{CD}_\text{rot}}$. The chunk outlined with an irregular shaped broken curve and located at the bottom of one of the left $\text{CD}_\text{rot}$ represents the $\text{EDA}^{\text{CD}_\text{rot}}$. Figures viib-viib show that at certain concentrations both $\text{EDA}^{\text{IPD}_\text{plasma}}$ and $\text{EDA}^{\text{CD}_\text{rot}}$ are present within $\text{CD}_\text{rot}$, though the sizes of $\text{EDA}^{\text{IPD}_\text{plasma}}$ diminish with concentration. Figure viib shows that on diluting further, no $\text{EDA}^{\text{IPD}_\text{plasma}}$ persist, i.e., there are too few solute particles to sustain $\text{EDA}^{\text{IPD}_\text{plasma}}$. At these concentrations, vigorous shaking just breaks up $\text{CD}_\text{rot}$ and creates new $\text{EDA}^{\text{CD}_\text{rot}}$. These in turn stabilize new $\text{CD}_\text{rot}$, as pictured in Figure viib. Figures viib-viib illustrate that $\text{CD}_\text{rot}$ may align with their dipole moments parallel. Figure viib illustrates that at certain concentrations their dipoles may be aligned anti-parallel. (Note that the sizes of the various domains, their broken pieces and the sizes of the solvated solutes with their hydration shells are not presented according to their realistic scale ratios.)

Figure 1

Figure 1

tion concentrations $C_{\text{trans}}^{\text{CD}_\text{plasma}}$ and $C_{\text{trans}}^{\text{IPD}_\text{plasma}}$ may be tiny, or solutes even might not organize in $\text{CD}_\text{plasma}$, i.e., these only organize in $\text{IPD}_\text{plasma}$. Incorporation of solvated solutes in $\text{IPD}_\text{plasma}$ may be the drive behind the solvation process of solutes with low solubility product constants. Critical micelle concentrations may equal $C_{\text{trans}}^{\text{CD}_\text{plasma}}$ or $C_{\text{trans}}^{\text{IPD}_\text{plasma}}$, but this has not yet been verified. $\text{IPD}_\text{plasma}$ may aggregate in supra-$\text{IPD}_\text{plasma}$. These domains may stabilize $\text{CD}_{\text{H}_2\text{O}}^{\text{H}_2\text{O}}$ and supra-$\text{CD}_{\text{H}_2\text{O}}^{\text{H}_2\text{O}}$ (see Figure 1 iiiib). Dilution below $C_{\text{trans}}^{\text{IPD}_\text{plasma}}$ diminishes the number of randomly moving solvated solutes as well as the number of solutes incorporated in $\text{IPD}_\text{plasma}$. At very low $C$ the number of solvated solutes is too low for formation of $\text{IPD}_\text{plasma}$. The aforesaid holds independent of the solutions’ preparation procedure, i.e., not just for SDVSPL, but also for solutions prepared without serial dilutions or vigorous shaking.

iii. For solutions containing $\text{IPD}_\text{plasma}$, their vigorous shaking affects their properties. The effect is the same as that for SDVSASES containing $\text{IPD}_\text{plasma}$. That is, vigorous shaking excites or breaks up $\text{IPD}_\text{plasma}$, as pointed out by Yinnon and Yinnon (2011) and Yinnon and Liu (2015b) (see Fig.1ivb). Excitations induce years-long lasting vortices in the superfluidic $\text{IPD}_\text{plasma}$ (Yinnon and Elia, 2013). [For short discussion on these vortices see Yinnon and Liu (2015a).] The vortices partly destroy the spherical sym-
metric alignments of the dipole moments of the solvent molecules surrounding the crystalline ordered solvated solutes in IPDplasma. Hence excited IPDplasma and their broken pieces have electric dipoles, i.e., are electric dipole aggregates, which we denote as EDAIPDplasma (see Figure 1ivb). EDAIPDplasma have the remnant crystalline structure of their “mother” IPDplasma (Yinnon and Yinnon, 2011; Yinnon and Elia, 2013). (As to CDplasma, only their solvation shells’ few solvent molecules are aligned, i.e., their perturbation, for example vigorous shaking, does not create 10⁻⁶ m-sized electric dipole aggregates.)

iv. For aqueous SDVSPLwe-ne, EDAIPDplasma induce electric dipoles in the quasi free electron clouds of CDH⁺. The interactions between the dipoles of these clouds, as well as between these and the dipole moments of EDAIPDplasma, may stabilize CDH⁺ and supra-CDH⁺ (see Figure 1ivb).

v. For concentrations less than the critical concentration for CDrot formation (i.e., C<CDrot, cr), due to the interactions between the dipoles of EDAIPDplasma and the dipoles of the solvent molecules, EDAIPDplasma stabilize CDrot and supra-CDrot (Yinnon and Yinnon, 2011; Yinnon and Elia, 2013) -- see Fig.1ivb. In other words, EDAIPDplasma, due to their significant asymmetric charge distributions, stabilize CDrot. Stabilization of CDrot also may be induced by solutes with sufficient large electric dipoles. Thus even when no IPDplasma and hence EDAplasma form in SDVSPLwe-ne, some types of non-electrolytic solutes still might induce CDrot stabilization for C<CDrot, cr, and subsequent vigorous shaking might create EDACDrot (and in aqueous solutions supra-CDrot<supra-CDH⁺ >) (Yinnon et al., 2011, 2013).

Vigorous shaking excites or breaks up CDrot (see Figure 1vb). Excitations induce years-long vortices in the superfluidic CDrot. Due to ferroelectric ordering of the molecules constituting CDrot, excited or broken CDrot also are electric dipole aggregates, i.e., EDACDrot (see Figure 1ivb). Unlike EDAIPDplasma, EDACDrot are not crystalline ordered. Due to interactions between the dipoles of EDACDrot and the polar solvent molecules, EDACDrot also stabilize CDrot. Therefore, serial dilutions with vigorous shaking at each dilution step diminish EDAIPDplasma but EDACDrot persist. These EDACDrot stabilize CDrot and supra-CDrot too. As a result CDrot persist up to ULC and beyond (Yinnon and Yinnon, 2011; Yinnon and Elia, 2013) (see Figures 1vib-viiiib). The aforementioned effects of vigorous shaking of SDVSPLwe-ne for C<CDrot are the same as those for SDVSASES described in Yinnon and Liu (2015b).

vi. In aqueous SDVSPLwe-ne, CDrot induce electric dipoles in the quasi free electron clouds of CDH⁺. The interactions between the dipole moments of these clouds, as well as between these and the dipole moments of EDAIPDplasma, may stabilize CDH⁺ and supra-CDH⁺, i.e., cause formation of [supra-CDH⁺ >] (Del Giudice et al., 2010). The aforementioned also holds for aqueous SDVSASES -- see Yinnon and Liu (2015b).

vii. QED domains affect physicochemical properties, requiring adjustment in customary equations. For example adjustments in equations describing electric conductivity are required because the following molecules do not collide: solvent molecules incorporated in the superfluidic domains (i.e, CDelec, CDrot, IPDplasma), solvent molecules in the hydration shells of solvated solutes in CDplasma; solvated solutes incorporated in CDplasma or in IPDplasma. Hence in polar liquids and their solutions, the electric conductivity is an inverse function only of intermolecular collisions involving: the randomly moving solvent and solute molecules not included in the domains; solvent molecules incorporated in CDplasma but not part of the solvation shells of the solutes.
included in these domains. A decrease of the fractions of these colliding particles enhances the electric conductivity. Also the electric dipole moments of EDA\textsuperscript{IPDplasma}, of CD\textsubscript{rot}, of EDA\textsuperscript{CDrot} and of the quasi free electron clouds of CD\textsuperscript{H\textsubscript{2}O\textsubscript{elec}} reduce intermolecular collisions of randomly moving molecules neighboring on these domains. The reductions raise electric conductivity (Yinnon and Yinnon 2011; Yinnon and Elia, 2013). Currently, we are investigating quantitative implications.

Rendering our above detailed qualitative SDVSPL\textsuperscript{we-ne} model into quantitative one requires numerous computations, which are beyond this paper’s scope.

Discussion

Correspondence between SDVSPL\textsuperscript{we-ne} properties predicted by QED and observed ones

Recently published experimental data, which evidence the characteristics of associates present in a SDVSPL\textsuperscript{we-ne} as predicted by its QED model (summarized in paragraphs i-viii above), we cite and discuss in paragraphs i-viii below.

i. For many weak electrolytes and non-electrolytes in various polar solvents, below a solute type dependent transition concentration of the order of \(1 - 10^{-3}\) M, part of the solvated solutes and numerous solvent molecules were observed to organize in \(10^{-7} - 10^{-6}\) m sized groupings. These groupings are not micelles. The groupings were observed with techniques like DLS, laser light scattering, static light scattering, nanoparticle tracking analysis, scanning electron microscopy and nuclear magnetic resonance (Li and Ogawa, 2000; Samal and Geckeler, 2001; Kononov \textit{et al.}, 2002; Sedlak, 2006; Sedlak and Rak, 2013; Hagmeyer \textit{et al.}, 2012; Konovalov, 2013; Ryzhkina \textit{et al.}, 2013). These groupings are present in serial diluted vigorously shaken solutions, as well as in solutions not perturbed by these techniques. These groupings have characteristics conforming to those of CD\textsubscript{plasma} and CD\textsuperscript{H\textsubscript{2}O\textsubscript{elec}} (Yinnon and Yinnon, 2009). It should be stressed, however, that for specific concentration ranges, numerous solutes form other cluster types which are not CD-plasma.

Identifying CD\textsubscript{plasma} is difficult, as holds for CD\textsuperscript{H\textsubscript{2}O\textsubscript{elec}} stabilized by CD\textsubscript{plasma}. (CD\textsuperscript{H\textsubscript{2}O\textsubscript{elec}} may also be stabilized by other cluster types.) EMF screening induced disappearance of groupings promises to be an effective method for exposing their QED nature. Radio frequency screening of tetra Hz to mega Hz EMF destroying \(10^{-6}\) m domains and UV EMF screening by Permalloy destroying \(10^{-7}\) m domains we expect to be optimal probes for identifying, respectively, CD\textsubscript{plasma} and CD\textsuperscript{H\textsubscript{2}O\textsubscript{elec}} (Yinnon and Liu, 2015b). An exemplary study partly corroborating this expectation is that of aqueous SDVSPL\textsuperscript{we-ne} of 2,4,6,8-tetramethyl-2,4,6,8-tetraazaabicyclo [3.3.0] octane-3,7-dione (the active ingredient in the tranquilizer Mebicar). For this SDVSPL\textsuperscript{we-ne}, Ryzhkina \textit{et al.} (2013) measured its groupings’ diameter under normal conditions (\(D_{lh}\), i.e., for samples kept at the laboratory bench. Moreover, they measured the groupings’ diameter (\(D_{p}\)) for samples kept in Permalloy containers. In samples kept at the laboratory bench, at \(10^{-2}\) M<\(C<10^{-1}\) M, clusters with \(D_{lh}\approx1.5\times10^{-9}\) m (hydrated solute molecules) and domains with \(D_{lh}\approx7\times10^{-6}\) m are present; on diluting to \(10^{-3}\) M, the \(D_{lh}\approx1.5\times10^{-9}\) m clusters disappear; at \(10^{-5}\) M<\(C<10^{-3}\) M, \(D_{lh}\approx8\times10^{-8}\) m and \(D_{lh}\approx2\times10^{-7}\) m domains are dominant. Screening samples by Permalloy does not significantly affect the domains present at \(10^{-2}\) M<\(C<10^{-1}\) M, evoking the \(D_{p}=D_{lh}\approx7\times10^{-6}\) m domains are CD-plasma. (Recall that the diameter of CD\textsubscript{plasma} is of the order of \(10^{-6}\) m.) Radio frequency screening of samples is called for to verify this evocation. Screening by Permalloy reduces prevalence and dominance of the \(8\times10^{-6}\) m and \(2\times10^{-7}\) m domains present.
at \(\sim 10^{-5} \text{ M} < C < 10^{-3} \text{ M}\); due to their diminished dominance, the \(D_{\text{p,trans}} \approx 7 \times 10^{-6} \text{ m}\) domains again become observable. Available electric conductivity data is insufficient for exposing a \(C_{\text{IPDplasma}}\), i.e., currently it is impossible to designate the \(D_{\text{h,b}} \approx 7 \times 10^{-6} \text{ m}\) domains present at \(10^{-2} \text{ M} < C < 10^{-1} \text{ M}\) and at \(10^{-5} \text{ M} < C < 10^{-3} \text{ M}\), respectively, as \(C_{\text{IPDplasma}}\) or IP-D_{\text{plasma}}. The fact that screening by Permalloy does destroy part but not all \(\sim 8 \times 10^{-8} \text{ m} \text{ and} \sim 2 \times 10^{-7} \text{ m}\) domains implies some of these might be \(C_{\text{Delec}}\). (Recall that the diameters of \(C_{\text{Delec}}\) and supra-\(C_{\text{Delec}}\) are of the order of \(10^{-7} \text{ m}\).) Those \(\sim 8 \times 10^{-8} \text{ m} \text{ and} \sim 2 \times 10^{-7} \text{ m}\) domains which were not destroyed by the Permalloy screening might be EDA_{\text{plasma}} -- as perhaps radio frequency screening can reveal. \(\zeta\)-potential data provides additional evidence for presence of \(C_{\text{Delec}}\). At \(10^{-3} \text{ M} < C < 10^{-2} \text{ M}\), the \(\zeta\)-potential varies between \(-11.5 \text{ mV}\) and \(-13 \text{ mV}\), which is compatible with the \(\zeta\)-potential of \(C_{\text{Delec}}\), as discussed below in paragraph vi.

For \(C < 10^{-6} \text{ M}\), \(10^{-7} \text{ m}\) and \(10^{-6} \text{ m}\) domains are present, but these disappear on screening by Permalloy, i.e., these are not \(C_{\text{IPDplasma}}\) or IP-D_{\text{plasma}}. A conclusion commensurate with the QED model, which predicts that at such low \(C\) the number of solutes is too small for forming a significant number of these domains. The domains present at \(C < 10^{-6} \text{ M}\) we discuss below in paragraph v.d.

ii. The domains observed in numerous \(\sim 10^{-6} \text{ M} < C < 10^{-4} \text{ M}\) weak- and non-electrolytes solutions, with properties differing from those of the domains present for \(C > 10^{-4} \text{ M}\), might be IP-D_{\text{plasma}}. Albeit, these could be other cluster types, e.g., micelles. Radio frequency screening destroying the domains will be required for identifying their IP-D_{\text{plasma}} nature. While we await such screening outcomes, for some exemplary solutions we present physicochemical data attributable to IP-D_{\text{plasma}} presence and \(C_{\text{Delec}}\) stabilized by these domains:

(a) For aqueous SDVSPL_{\text{we-ne}} of Melafen [the melamine salt of bis(hydroxymethyl) phosphinic acid dihydrate] in water (with 1% D2O) Konovalov et al. (2008) found: their dilution from \(1 \times 10^{-3} \text{ M}\) to \(1 \times 10^{-4} \text{ M}\) reduces the UV absorption coefficient from 31900 to 30000, but on further dilution it increases to 34700 and 43500, respectively, for \(1 \times 10^{-5} \text{ M}\) and \(1 \times 10^{-6} \text{ M};\) other UV spectral features indicate at \(\sim 2 \times 10^{-3} \text{ M}\) the solution has a salt character; Infra Red (IR) spectra indicate for \(\sim 8 \times 10^{-2} \text{ M} < C < 1 \times 10^{-1} \text{ M}\) Melafen dissociates into anions and cations with their hydration shell surrounded by a mobile \(H_2O\) network; with the ionic nature of aqueous Melafen for \(C > 10^{-3} \text{ M}\), the reduction in UV absorption observed on diluting from \(1 \times 10^{-3} \text{ M}\) to \(1 \times 10^{-4} \text{ M}\) corresponds to that typical for salt solutions, while the increase in UV absorption for \(C < 10^{-4} \text{ M}\) is attributable to association of ions. The aforementioned concurs with the ionic associates present at \(C < 10^{-4} \text{ M}\) being IP-D_{\text{plasma}}, which stabilize \(C_{\text{Delec}}\) interacting with UV EMF. Also for SDVSPL_{\text{we-ne}} of hemin derivatives at \(\sim 1 \times 10^{-6} \text{ M} < C < \sim 1 \times 10^{-4} \text{ M}\) Ryzhkina et al. (2011c) measured UV absorbance. They concluded its enhancements with dilution are ascribable to various types of aggregates. As to their nature, e.g., these are IP-D_{\text{plasma}} which stabilize \(C_{\text{Delec}}\), the current available data is insufficient for reaching at conclusions and EMF screening is called for.

(b) For aqueous SDVSPL_{\text{we-ne}} of the antioxidant Ichfan C-10 (a 2,6-dialkylphenol derivative), Ryzhkina et al. (2009a, 2011d) showed:

1. For \(C\) above the critical micelle concentration (\(\sim 1 \times 10^{-3} \text{ M}\)), surface tension of samples kept at the laboratory bench \((\sigma_{\text{h,b}})\) or in Permalloy containers \((\sigma_p)\) indicate it is a functional cationic surfactant. Electrophoresis evidence their micelles’ \(\zeta\)-potential varies from 40 to 15 mV.

2. On diluting from \(\sim 1 \times 10^{-3} \text{ M}\) to \(\sim 5 \times 10^{-
7 M, $D_{lb}$ increases from ~1.0x10^{-7} m to ~1.6x10^{-7} m, the ζ-potential of associates in samples kept at the laboratory bench ($ζ_{lb}$) drops to -12 mV, and $σ_{lb}$ strongly increases approaching that of double distilled water thus indicating the domains are not micelles or pre-micelle aggregates. 

3. For samples kept on the laboratory bench, domain size distributions are unimodal for ~10^{-6} M<C<~10^{-3} M. However, for samples kept for 18 hours in Permalloy containers the distributions are not unimodal for ~10^{-9} M<C<~10^{-5} M. Clusters with ~10^{-9} m <$D_p$<~10^{-8} m and domains with ~10^{-7} m <$D_p$<~10^{-6} m persist.

4. At ~10^{-7} M<C<~10^{-5} M, the electric conductivity of samples kept at the laboratory bench ($χ_{lb}$) are slightly larger than the electric conductivity of samples kept in Permalloy containers ($χ_P$). For this concentration range also $σ_{lb}$ is slightly larger than $σ_P$.

Paragraphs 2-4 mentioned changes in physicochemical variables observed on diluting from ~10^{-3} M to ~10^{-7} M indeed are attributable to micelles transforming to IPD$_{plasma}$ which in turn stabilize CD$_{elec}^{H_0}$, e.g.: $D_p$≈10^{-6} m conforms to the ~10^{-6} m diameter of IPD$_{plasma}$; $D_{lb}$≈10^{-7} m conforms to the ~10^{-7} m diameter of CD$_{elec}^{H_0}$; $ζ_{lb}$= -12 mV is ascribable to the quasi free electrons of CD$_{elec}^{H_0}$; $χ_{lb}$ versus $χ_P$ and $σ_{lb}$ versus $σ_P$ discrepancies are attributable to the ζ-potential and the dipole moment of the distorted clouds of quasi free electrons of CD$_{elec}^{H_0}$. The $χ_{lb}$ versus $χ_P$ discrepancies are also attributable to the superfluidity of CD$_{elec}^{H_0}$. Studying the effects of radio frequency screening is required for evidencing the IPD$_{plasma}$ nature of the domains. Such screening is also desirable for other solutions, e.g., aqueous SDVSPL$_{we-ne}$ of potassium phenosan, α-tocopherol or membranotropic amphiphilic calix[4]resorcinarene with tris(hydroxymethyl)methylamide functional groups, because Ryzhkina et al. (2012a,c) observed these solutions have physicochemical properties similar to aforementioned ones for Ichfan C-10.

iii. Creation of EDA$_{IPDplasma}$ by vigorous shaking of solutions requires IPD$_{plasma}$ presence, which as discussed above, still has to be unambiguous evidenced for SDVSPL$_{we-ne}$. Radio frequency screening and Fourier transform analyses of the molar conductivity dependence on time for assessing EDA$_{IPDplasma}$ presence are called for. The benefits of such Fourier transform analyses is discussed in Yinnon and Liu (2015b).

iv. As to CD$_{elec}^{H_0}$ stabilized by EDA$_{plasma}$, their presence in aqueous SDVSPL$_{we-ne}$ can be revealed by $D_{lb}$, $D_p$, $χ_{lb}$ and $χ_P$ data. However, clusters other than EDA$_{IPDplasma}$ e.g., micelles or pre-micelle aggregates, might also underlie CD$_{elec}^{H_0}$ stabilization. While we wait for verification of presence of EDA$_{IPDplasma}$ by the techniques mentioned in paragraph iii, in the meanwhile for some exemplary SDVSPL$_{we-ne}$ we present physicochemical data consistent with CD$_{elec}^{H_0}$ presence. For aqueous SDVSPL$_{we-ne}$ of Ichfan C-10, potassium phenosan, and α-tocopherol, Ryzhkina et al. (2011d, 2012a, 2012c) showed EMF affect these SDVSPL$_{we-ne}$ differently at ~10^{-20} M<C<~10^{-3} M with ~10^{-10} M<C<~10^{-6} M:

(a) For $C_{thr}$<C<~10^{-3}M, $D_{lb}$ distributions are unimodal with ~10^{-7} m <$D_{lb}$<~3.5x10^{-7} m. However, $D_p$ distributions are not unimodal: clusters with 10^{-9} m <$D_p$<10^{-8} m and domains with 5x10^{-8} m <$D_p$<~4x10^{-6} m are distinguishable. For C<C$_{thr}$, no domains are present in samples kept for 18 hours in Permalloy containers and the liquid loses its typical SDVSPL$_{we-ne}$ physicochemical properties. The aforementioned unimodality and values of $D_{lb}$ are commensurate with supra-CD$_{elec}^{H_0}$ dominating the domain distribution and mainly determining $D_{lb}$. The 5x10^{-8} <$D_p$<~4x10^{-6} m domains might be EDA$_{IPDplasma}$ and the 10^{-9} m <$D_p$<10^{-8} m clusters might be hydrated ions, which become distinguishable.
with DLS when the more abundant CD\textsubscript{elec}$^{H,0}$ are eliminated by the Permalloy container screening UV EMF.

(b) For $C_{\text{thr}}$$<$$C$$<$$10^{-5}$ M $\chi_P$ is about 10% lower than $\chi_{\text{lb}}$. The difference is solute type dependent. It is attributable to CD\textsubscript{elec}$^{H,0}$ and supra-CD\textsubscript{elec}$^{H,0}$ stabilized by EDA\textsuperscript{PPDplasma} or other cluster types in samples kept at the laboratory bench. Recall that CD\textsubscript{elec}$^{H,0}$ are superfluidic. Therefore on their disappearance the number of intermolecular collisions increases and $\chi$ decreases.

v. For $C$$<$$C_{\text{crit}}$, fingerprints of ferroelectric orderings participating in dissipative dynamics were identified in $\chi$, heat of mixing and pH data of SDVSPL\textsuperscript{we-ne} (Elia and Niccoli, 1999, 2004a). These fingerprints were attributed to CD\textsubscript{rot} and EDA\textsubscript{CDrot} by Yinnon and Yinnon (2011) and Yinnon and Elia (2013). In serial diluted solutions which were not vigorously shaken after each dilution step, no such fingerprints were observed. Also IR spectra pass band coefficient fluctuations (IR-SPBCF) of several aqueous SDVSPL\textsuperscript{we-ne}, observed by Zubareva \textit{et al} (2003), are attributable to the dissipative dynamics of CD\textsubscript{rot} and EDA\textsubscript{CDrot}. These IR-SPBCF resemble those of SDVSASES. The latter were shown to conform with CD\textsubscript{rot} and EDA\textsubscript{CDrot} agglomeration and reorganization in supra-domains (Yinnon and Liu, 2015b).

\textit{Dielcometric titrations\textsuperscript{d} provided the first}

\textsuperscript{d} Dielcometric titrations provide the dependence of the dielectric permittivity ($\varepsilon$) on $C$, \textit{i.e.} $\varepsilon(C)$. As to $\varepsilon(C)$, its deviation from linearity is a measure of intermolecular interactions of the mixture’s components, with slope ratios characterizing its polarization affinity. Usually, the slope ratio of $\varepsilon(C)$ changes upon formation of associates. A sharp positively sloped $\varepsilon(C)$ leveling off in a plateau is characteristic of linear ordering of subunits and formation of “chain associates” in which the dipole moments are more or less parallel oriented. On increasing unambiguous evidence for ferroelectric ordering in non-aqueous and aqueous SDVSPL\textsuperscript{we-ne} and showed the type of ordering depends on concentration (Konovalov \textit{et al}., 2008):

(a) For SDVSPL\textsuperscript{we-ne} of Melafen with the low-polarity chloroform as solvent, the dielectric permittivity ($\varepsilon$) dependence on $C$, \textit{i.e.}, $\varepsilon(C)$ has two inflection points in the $10^{-10}$ M$<$$C$$<$$10^{-4}$ M range: for $10^{-10}$ M$<$$C$$<$$3.3x10^{-8}$ M $\varepsilon(C)$ is linear with a steep slope; for $3.3x10^{-8}$ M$<$$C$$<$$6.6x10^{-6}$ M $\varepsilon(C)$ is linear too but the slope is about half that one for $10^{-10}$ M$<$$C$$<$$3.3x10^{-8}$ M; at $6.6x10^{-6}$ M $\varepsilon(C)$ reaches a plateau which continues up to $C$$<$$1x10^{-4}$ M (Konovalov \textit{et al}., 2008). Based on the well known $\varepsilon(C)$ characteristics: the steeply sloped $\varepsilon(C)$ is attributable to chain associates of CD\textsubscript{rot} and EDA\textsubscript{CDrot}; the moderately sloped $\varepsilon(C)$ is attributable to these domains being organized in multipole aggregates; the plateau at $6.6x10^{-6}$ M$<$$C$$<$$1x10^{-4}$ M is attributable to EDA\textsuperscript{PPDplasma} organized with their dipoles “inverse-parallel” orientated or to other non-polar groupings. The aforementioned hints that $C_{\text{crit}}$ of CD\textsubscript{rot} is about $10^{-6}$ M. To verify this paragraph’s attributions, EMF screening of SDVSPL\textsuperscript{we-ne} of Melafen is called for, because association of the molecules constituting CD\textsubscript{rot} is mediated by FIR EMF.

(b) Our model’s assumption that domain formation in SDVSPL\textsuperscript{we-ne} at low and ul-

\begin{equation}
C
\end{equation}

above that of the plateau, $\varepsilon(C)$ may become negatively sloped and reach a new plateau due to additional association leading to multipole aggregates with associated particles’ dipoles “inverse-parallel” orientated leading to formation of non-polar aggregates. The non-polar aggregates with the “inverse parallel orientation” can also form at the first step of aggregation, omitting the “chain aggregate” phase. The transition point at which the slope of $\varepsilon(C)$ changes corresponds to the critical aggregate concentration \textit{e.g.}, critical micelle concentration, if the solute is a surfactant.
tralow concentrations involves the dipoles of the polar solvent molecules is supported by \(\varepsilon(C)\) of SDVSPL\(^{we-ne}\) of \(\alpha\)-tocopherol in the non-polar carbon tetrachloride versus that in chloroform (Ryzhkina et al., 2011b). For the former at \(\approx 10^{-24} M < C < 10^{-3} M\), \(\varepsilon(C)\) is linear and only slightly changes, indicating absence of association. For the latter at \(\approx 10^{-20} M < C < 10^{-3} M\), \(\varepsilon(C)\) is non-linear and has kinks at \(C \approx 10^{-20} M\), \(C \approx 10^{-15} M\) and \(C \approx 10^{-10} M\). The kinks are related to formation and rearrangement of domains. For \(\approx 10^{-20} M < C < 10^{-15} M\), growth of \(\varepsilon\) with \(C\) is steepest, but lessens when \(C\) increases. For \(\approx 10^{-4} M < C < 10^{-3} M\), \(\varepsilon(C)\) is flat. The aforementioned \(\varepsilon(C)\) features indicate domains only form in SDVSPL\(^{we-ne}\) with polar solvent molecules.

(c) For aqueous SDVSPL\(^{we-ne}\) of membraneotropic amphiphilic calix[4] resorcin-arene with tris(hydroxymethyl)methylamide functional groups (a compound with structure and properties rendering it a simple synthetic model of natural polypeptide cluster glycoconjugates inducing cascades of physiological reactions when binding to cell membranes), Ryzhkina et al. (2012c) also employed dielectricometry to evidence ferroelectric ordering. They found for the concentration dependence of \(\Delta \varepsilon\) \([i.e., \Delta \varepsilon(C)\) with \(\Delta \varepsilon\) the difference between \(\varepsilon\) of this SDVSPL\(^{we-ne}\) and \(\varepsilon\) of double distilled water\): on diluting from \(\approx 10^{-4} M\) to \(\approx 10^{-8} M\) \(\Delta \varepsilon\) decreases from 7.5 to 0, on diluting from \(\approx 10^{-5} M\) to \(\approx 5 \times 10^{-7} M\) \(\Delta \varepsilon\) stays 0, on diluting from \(\approx 5 \times 10^{-7} M\) to \(\approx 5 \times 10^{-8} M\) \(\Delta \varepsilon\) increases from 0 to \(\approx 1\), on diluting from \(\approx 5 \times 10^{-8} M\) to \(\approx 3 \times 10^{-9} M\) \(\Delta \varepsilon\) increases to \(\approx 1.5\), on diluting from \(\approx 3 \times 10^{-9} M\) to \(\approx 10^{-10} M\) \(\Delta \varepsilon\) decreases to \(\approx 0.75\), on diluting from \(\approx 10^{-10} M\) to \(\approx 5 \times 10^{-11} M\) \(\Delta \varepsilon\) increases to \(\approx 1\) and on diluting from \(\approx 5 \times 10^{-11} M\) to \(\approx 10^{-12} M\) \(\Delta \varepsilon\) decreases to \(\approx 0.5\) (see Ryzhkina et al. 2012c Figure 2). In addition they demonstrated the orderings induce optical activity. By combining their \(\Delta \varepsilon\), optical activity and \(\mathcal{D}_{lb}\) data, they evidenced different types of groupings containing ferroelectric-ordered molecules cause this \(\Delta \varepsilon(C)\): for \(\approx 10^{-6} M < C < 10^{-3} M\) the \(\mathcal{D}_{lb}\) distribution is bimodal with \(\mathcal{D}_{lb} \approx 4 \times 10^{-9} m\) clusters and \(\approx 1.2 \times 10^{-7} m < \mathcal{D}_{lb} < 1.8 \times 10^{-7} m\) domains (on dilution from \(\approx 1 \times 10^{-3} M\) to \(\approx 1 \times 10^{-5} M\) the fraction of the \(\mathcal{D}_{lb} \approx 4 \times 10^{-9} m\) clusters decreases from 0.3 to 0.1 while that of the \(\mathcal{D}_{lb} \approx 10^{-7} m\) domains increases to 0.9); for \(\approx 10^{-12} M < C < 10^{-7} M\) the \(\mathcal{D}_{lb}\) distribution is bimodal with \(\mathcal{D}_{lb}\) of the order of \(10^{-7} m\) and \(10^{-6} m\) and their fractions respectively 0.7 and 0.3; for \(C < 10^{-12} M\) the domain distribution is polymodal preventing assessment of \(\mathcal{D}_{lb}\). Their \(\sigma_{lb}\) data evidence the solute is not a surfactant at \(\approx 10^{-12} M < C < 10^{-3} M\). They supplemented their \(\mathcal{D}_{lb}\) data with atomic force microscopy (AFM) imaging. AFM in contact mode for \(\approx 10^{-6} M < C < 10^{-3} M\) revealed \(1 \times 10^{-7} m - 6 \times 10^{-7} m\) wide up to \(3.5 \times 10^{-8} m\) high hemispherical discrete relief particles, with the largest particles composed of smaller ones and all particles randomly distributed on the substrate -- their prevalence strongly diminishes with concentration. At \(C \approx 10^{-7} M\) the discrete particles are still present, but AFM in tapping mode revealed another type of particles appears: \(\approx 8 \times 10^{-8} m\) wide \(1.3 \times 10^{-9} m - 1.7 \times 10^{-9} m\) high chain oriented soft particles aggregated in a thin film covering the substrate (similar soft particles were observed for aqueous NaCl SDVSASES at \(C \approx 1.7 \times 10^{-7} M\) (Lo et al., 2009). For \(\approx 10^{-11} M < C < 10^{-8} M\), AFM in tapping mode exposed \(\approx 10^{-6} m\) sized soft particles forming different complex structures, e.g., ribbon or rounded configurations (similar ribbons were observed with Transmission Electron Microscopy of aqueous NaCl SDVSASES at \(C \approx 10^{-11} M\) (Lo, 1996). The aforementioned \(\mathcal{D}_{lb}\) and AFM analyses of Ryzhkina et al. (2012c) expounded the groupings present at \(\approx 10^{-6} M < C < 10^{-3} M\) are associates composed of solute and solvent molecules, while the domains present for \(C < 10^{-7} M\) are mainly composed of solvent.
molecules. Placing samples for 18 hours in Permalloy containers also enabled them to unambiguously demonstrate the different nature of the groupings present at C below and above $10^{-7}$ M: for $C<10^{-7}$ M no groupings are distinguishable, i.e., $C_{\text{thr}} \approx 10^{-7}$ M; at $\sim 10^{-6}$ M $< C < 10^{-3}$ M samples’ physico-chemical properties are slightly altered. While the alterations are attributable to CD$_\text{H}^0\text{e}_{\text{lec}}$ stabilized by other groupings types, radio frequency screening and examining its effect on $\Delta \varepsilon(C)$ are called for to investigate whether these groupings include IPEP$\text{D}_{\text{plasma}}$ and EDA$\text{IPD}_{\text{plasma}}$. With the $10^{-7}$ M and $10^{-6}$ M groupings present at $C<10^{-7}$ M mainly being composed of $\text{H}_2\text{O}$, the disappearance of these on screening by Permalloy and the ferroelectric ordering of their molecules exposed by above cited $\Delta \varepsilon(C)$ data, the properties of these groupings match those of CD$_\text{rot}$, EDA$\text{CD}_{\text{rot}}$, CD$_\text{H}^0\text{e}_{\text{elec}}$ and $[\text{supra-CD}_{\text{rot}} < \text{supra-CD}_{\text{H}^0\text{e}_{\text{elec}}}]$, implying $C_{\text{crit}}^{\text{CD}_{\text{rot}}} \approx C_{\text{thr}} \approx 10^{-7}$ M. As to the AFM data and the detailed $\Delta \varepsilon$ values, according to theoretical aspects of $\Delta \varepsilon(C)$ summarized in footnote d: for $\sim 3 \times 10^{-8}$ M $< C < \sim 5 \times 10^{-7}$ M these are ascribable to chain structures of CD$_\text{rot}$ and EDA$\text{CD}_{\text{rot}}$, with these domains’ electric dipole moments parallel oriented; for $\sim 1 \times 10^{-10}$ M $< C < \sim 3 \times 10^{-8}$ M the kinks in $\Delta \varepsilon(C)$ signifies changes in the arrangement of these electric dipole moments, e.g., these are attributable to polar chain as well as less polar multi-pole structures; the maximum of $\Delta \varepsilon(C)$ at $C \approx 10^{-11}$ M also is ascribable to polar chain structures dominating the groupings’ distribution. This attribution is supported by the non-zero optical activity observed for this $C$ range.

(d) For $\sim 10^{-18}$ M $\leq C \leq C_{\text{thr}} \approx 10^{-6}$ M aqueous SDVSPL$\text{we-ne}$ of 2,4,6,8-tetramethyl-2,4,6,8-tetraazabicyclo[3.3.0] octane-3,7-dione (Mebicar), Ryzhkina et al. (2013) also demonstrated ferroelectric ordering. It disappears on screening by Permalloy. With DLS they observed $D_{\text{lb}} \approx 10^{-7}$ m and $D_{\text{lb}} \approx 10^{-6}$ m domains, which disappear on screening by Permalloy. With dielcometry they evidenced $\Delta \varepsilon$ of samples kept at the laboratory bench ($\Delta \varepsilon_{\text{b}}$) strongly depends on concentration. It varies between about -1.5 and +1, indicating ferroelectric ordering of the domains depends on concentration. Negative $\Delta \varepsilon_{\text{b}}$ values signifying domains form low-polar multipole structures, thus decreasing $\varepsilon$ of the solution below that of double distilled water. The maximal positive $\Delta \varepsilon_{\text{b}}$ at $\sim 1 \times 10^{-10}$ M is attributable to domains forming chain (ribbon) structures wherein the dipole moments are arranged uni-directionally. $\Delta \varepsilon(C)$ for samples screened by Permalloy, i.e., $\Delta \varepsilon_p(C)$, equals 0. With $D_{\text{lb}} \approx 10^{-6}$ m domains present at $C < 10^{-6}$ M, these mainly being composed of $\text{H}_2\text{O}$, their disappearance on screening by Permalloy and the ferroelectric ordering of their molecules exposed by dielcometry, the properties of these domains match those of CD$_\text{rot}$ and EDA$\text{CD}_{\text{rot}}$, implying $C_{\text{crit}}^{\text{CD}_{\text{rot}}} \approx C_{\text{thr}} \approx 10^{-6}$ M. Characteristics of the $\sim 10^{-7}$ m domains, which we discuss below in paragraph vi, indicate these are CD$_\text{H}^0\text{e}_{\text{elec}}$.

(e) $\sigma_{\text{lb}}$ dependence on C [i.e. $\sigma_{\text{lb}}(C)$ ] supplements the $\Delta \varepsilon_{\text{lb}}(C)$ reflecting the inverse-parallel oriented polar domains versus polar chain domains orderings for $10^{-18}$ M $< C < C_{\text{crit}}^{\text{CD}_{\text{rot}}} \approx C_{\text{thr}}$ aqueous SDVSPL$\text{we-ne}$: Ryzhkina et al. (2009, 2011c-d) for various aqueous SDVSPL$\text{we-ne}$ observed in this C range (which is below these solutions’ critical micelle concentration), that $\sigma_{\text{lb}}$ equals the surface tension of double distilled water, with the exception of two broad minima, one near $C \approx C_{\text{crit}}^{\text{CD}_{\text{rot}}}$ and the other near $C \approx 10^{-13}$ M for aqueous SDVSPL$\text{we-ne}$ of Ichfan C-10 or near $C \approx 10^{-16}$ M for a Hemin derivative.

This section’s cited experimental data indicate: domains are present for $C < C_{\text{crit}}$ for SDVSPL$\text{we-ne}$ of certain solute and solvent types only when during their preparation after each dilution step the liquid is vigorously shaken; for $C < C_{\text{crit}}$ domains only

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are present in polar solvents; the numerous solvent molecules constituting these domains are ferroelectric ordered; these domains aggregate into chain or multipole structures; these domains disappear on screening by Permalloy. These indications evoke the domains include CDrot and EDA\(_{\text{CDrot}}\) and \(C_{\text{crit}} = C_{\text{CDrot}}\). (Our discussion as to these domains also including CD\(_{\text{elec}}\)\(\text{H}_2\text{O}\) at \(C < C_{\text{crit}}\), we present in paragraph vi.) Aforementioned evocation replaces the enigma “Why does SDVSPL\(_{\text{we-ne}}\) of some solutes at ULC contain domains while others have the customary infinite diluted solutions characteristics?” to the query “Which entity stabilize CDrot at \(C_{\text{crit}} \text{CDrot}\)?” With the current fuzziness concerning IPD\(_{\text{plasma}}\) and EDA\(_{\text{IPD}}\) presence in SDVSPL\(_{\text{we-ne}}\), we cannot assess whether solvated solutes with a sufficiently large asymmetric charge distribution or only EDA\(_{\text{IPD}}\) stabilize CDrot at \(C_{\text{crit}}\). Since IPD\(_{\text{plasma}}\) and EDA\(_{\text{IPD}}\) formations both require solvated solutes with a sufficiently large asymmetric charge distribution, we contend that only SDVSPL\(_{\text{we-ne}}\) of such solutes contain CDrot at ULC. As a first step towards verifying our contention, in Table 1 we present a variety of bioactive compounds and their measured or calculated electric dipole moment reported in the literature. We randomly choose these compounds from those listed by Konovalov (2013). Based on our SDVSPL\(_{\text{we-ne}}\) model, we predict that only in ULC SDVSPL\(_{\text{we-ne}}\) of bioactive compounds which have a dipole moment larger than the dipole moment of the solvent molecules, CDrot and EDA\(_{\text{CDrot}}\) are present for \(C < C_{\text{CDrot}} = C_{\text{thr}}\). Since for \(\text{H}_2\text{O}\) in its gas phase, the electric dipole moment is 1.85 D and in liquid phase its values has been estimated as 2.9±0.6D (Kemp et al., 2008), we predict that only when the dipole moment of the bioactive compound is above ~3D, their ULC aqueous SDVSPL\(_{\text{we-ne}}\) contain CDrot and EDA\(_{\text{CDrot}}\). Table 1 presents our predictions. Measurements confirming these predictions are called for.

### Table 1: SDVSPL\(_{\text{we-ne}}\) of bioactive compounds and predictions concerning these liquids containing domains at ULC. The symbol “V” indicates that our model predicts presence of domains in ULC SDVSPL\(_{\text{we-ne}}\). The symbol “?” indicates that according to our model it is doubtful that domains are present in ULC SDVSPL\(_{\text{we-ne}}\). The symbol “-” indicates that our model predicts no domains are present in ULC SDVSPL\(_{\text{we-ne}}\).

<table>
<thead>
<tr>
<th>BAC</th>
<th>Electric dipole moment (Debye)</th>
<th>Theory predicts domain formation</th>
<th>Reference to electric dipole moment of bioactive compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino benzoic acid</td>
<td>3.3</td>
<td>V</td>
<td>Kondrashina et al. (1994)</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>9.0</td>
<td>V</td>
<td>Nelson et al. (1967)</td>
</tr>
<tr>
<td>Acetosalicic acid</td>
<td>1.9</td>
<td>-</td>
<td>Cabezas et al. (2012)</td>
</tr>
<tr>
<td>Adenine</td>
<td>3.1 (in water)</td>
<td>?</td>
<td>Li et al. (1999).</td>
</tr>
<tr>
<td>(\beta)-Sitosterol</td>
<td>2.5</td>
<td>-</td>
<td>Kurban et al. (2010).</td>
</tr>
<tr>
<td>Thyrotropin-releasing hormone</td>
<td>5.7</td>
<td>V</td>
<td>Protirelin - bioinformatics. charite. de/main/content/databases: cas=024305279.</td>
</tr>
<tr>
<td>B-Cyclodextrin</td>
<td>~3</td>
<td>V</td>
<td>Botsi et al. (1996).</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>2.0</td>
<td>-</td>
<td>McClellan (1963)</td>
</tr>
<tr>
<td>Isoniazid</td>
<td>2.0</td>
<td>-</td>
<td>Rajalakshmi et al. (2011)</td>
</tr>
<tr>
<td>Lysine</td>
<td>4.0</td>
<td>V</td>
<td>Kumazaki and Shintaro (1972)</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>16.0</td>
<td>V</td>
<td>Felder an Sussman (2014)</td>
</tr>
<tr>
<td>Uracil</td>
<td>6.0</td>
<td>V</td>
<td>Li et al. (1999).</td>
</tr>
</tbody>
</table>

vi. CD\(_{\text{elec}}\)\(\text{H}_2\text{O}\) stabilized by CDrot cannot be evidenced by examining differences between physicochemical properties of samples kept at the laboratory bench or in Permalloy containers. Such differences we analyzed in paragraphs i, ii and iv for uncovering CD\(_{\text{elec}}\) stabilization by CD\(_{\text{plasma}}\), IPD\(_{\text{plasma}}\) or EDA\(_{\text{plasma}}\). However, screening by Permalloy destroys both CD\(_{\text{elec}}\) and CDrot. With UV
absorbance sensitive to $CD_{\text{elec}}^{H_2O}$ (Del Giudice et al., 2010; Yinnon et al., 2015c), gathering UV absorbance data for various SDVSPL$_{\text{we-ne}}$ with $C\ll C_{\text{thr}} \approx C_{\text{CDrot}}$ is called for. While awaiting such measurements, we focus on $CD_{\text{elec}}^{H_2O}$ fingerprints in $\zeta$-potential data, because many physicochemical properties of dispersed systems are determined by their dispersed particles’ surface charge. Ryzhkina et al. (2010a, 2011d, 2012a-d, 2013) observed: $\zeta_{\text{lb}}$ of the $D_{\text{lb}}\approx 1 \times 10^{-7}$ m to $D_{\text{lb}}\approx 4 \times 10^{-7}$ m sized domains, present in aqueous SDVSPL$_{\text{we-ne}}$ at $\sim 10^{-20}$ M $< C < C_{\text{thr}}$ (which we denote $\zeta_{\text{lb}}$) typically varies from -2 to $-20$ mV, non-linear changes with concentration and is related to their $D_{\text{lb}}$ (which we denote $D_{\text{lb}}^{1 \times 10^{-7} - 4 \times 10^{-7} \text{m}}$); $\zeta_{\text{lb}}$ also is related to the $\Delta C_{\text{lb}}$ and $\text{pH}$ of samples kept at the laboratory bench (pH$_{\text{lb}}$); $\zeta_{\text{lb}}$ correlates with $\chi_{\text{lb}}$ at solute type dependent concentration ranges. (In the aforementioned and the rest of this paragraph, we only cited data for $\sim 10^{-20}$ M $< C < C_{\text{thr}}$, samples kept at the laboratory bench, because at these concentrations no domains are present in samples screened by Permalloy.) With the diameter of $CD_{\text{elec}}^{H_2O}$ and the size of supra-$CD_{\text{elec}}^{H_2O}$ of the order of $10^{-7}$ m (similar to $D_{\text{lb}}^{1 \times 10^{-7} - 4 \times 10^{-7} \text{m}}$), we conjecture: the negative charged domains are $CD_{\text{elec}}^{H_2O}$ and supra-$CD_{\text{elec}}^{H_2O}$, $\zeta_{\text{lb}}^{1 \times 10^{-7} - 4 \times 10^{-7} \text{m}}$ is due to the quasi free electrons located at their boundary; pH$_{\text{lb}}$ (typically varying from $\sim 5.8$ to 7) result from the quasi free protons (which are the partners of the quasi free electrons) and are dispersed in the solvent surrounding CD$_{\text{rot}}$. As to the reasoning underlying this conjecture, for an H$_2$O ensemble with finite dimensions, ferroelectric ordering implies addition of an electrostatic term to its potential energy [the 2nd term in Eq. 4 of Itatka (2010)], representing the effect of the macroscopic electric field due to the charge distribution at the boundary. This term’s contribution to the potential energy is about hundred times larger than the energetic differences of various hydrogen bond configurations. Alike charged particles, dispersed within the ensemble, screen the boundary polarization and reduce this term. Hence accumulation of alike charged particles in CD$_{\text{rot}}$ and expulsion of opposite charged ones reduce polarization at the CD$_{\text{rot}}$ boundary and stabilize these domains. Apparently, the energy gained from CD$_{\text{rot}}$ stabilization is higher than that required for separating the quasi free electrons of $CD_{\text{elec}}^{H_2O}$ from their quasi free protons. Thus on CD$_{\text{rot}}$ stabilization: some H$_2$O incorporated in $CD_{\text{elec}}^{H_2O}$ dissociate (i.e., their dissociation constant shifts); those quasi free protons becoming hydroxonium ions (H$_3$O$^+$) disperse in between the CD$_{\text{rot}}$ causing the solvent’s slightly acid character; their counterions, the negatively charged $CD_{\text{elec}}^{H_2O}$, locate within the CD$_{\text{rot}}$ and screen their boundary polarization. With calculation of the energetic changes involved in the mechanisms outside the scope of this paper, we turn to other data supporting our conjecture.

For aqueous SDVSPL$_{\text{we-ne}}$ of 2,4,6,8-tetramethyl-2,4,6,8-tetraazabicyclo [3.3.0] octane-3,7-dione at $\sim 10^{-17}$ M $< C < C_{\text{thr}}$ (Mebicar), Ryzhkina et al. (2013) found: the molarities at which the dependence of pH$_{\text{lb}}$ and $D_{\text{lb}}^{1 \times 10^{-7} - 4 \times 10^{-7} \text{m}}$ on concentration have maximum coincide; for $\sim 10^{-16}$ M $< C < \sim 10^{-10}$ M, pH$_{\text{lb}}$ and $D_{\text{lb}}^{1 \times 10^{-7} - 4 \times 10^{-7} \text{m}}$ statistically significantly correlate. The findings indicate domains reorganization involves H$_3$O$^+$. Indeed according to QED, $CD_{\text{elec}}^{H_2O}$ organizing in supra-$CD_{\text{elec}}^{H_2O}$ affects the energy levels of their quasi free electrons and quasi free protons (Preparata, 1995 chapters 3 and 10), altering the dissociation energy of their H$_2$O. To the best of our knowledge, the aforementioned correlation is its first identified manifestation. However, such correlation was not observed for all SDVSPL$_{\text{we-ne}}$ for which pH$_{\text{lb}}$ data were collected (Ryzhkina et al., 2012c). With the still rudimentary understanding of the effects of $CD_{\text{elec}}^{H_2O}$ agglomeration on the quasi free electrons and the quasi free protons, detailed calculations and comparing their results with pH$_{\text{lb}}$ and $D_{\text{lb}}^{1 \times 10^{-7} - 4 \times 10^{-7} \text{m}}$ data
analyses are called for.

With $\varphi_{lb}^{1.10^{-7}-4.10^{-7}m}$ and $D_{lb}^{1.10^{-7}-4.10^{-7}m}$ for many SDVSPL\textsuperscript{we-ne} at $C<C_{thr}$ related but not statistically significantly correlated, the effects of $\text{CD}^{H_0}_{\text{elec}}$ organizing in supra-CD\text{elec}\textsuperscript{H_0} seems to be influenced by quasi free electrons as well as by other factors, e.g., the polarization density in their neighborhood. Indeed, the extremums in the absolute values of $\varphi_{lb}^{1.10^{-7}-4.10^{-7}m}$ (i.e., $|\varphi_{lb}^{1.10^{-7}-4.10^{-7}m}|$) coincide with those of $\Delta\varepsilon_{lb}$ for aqueous SDVSPL\textsuperscript{we-ne} of Mebicar at $C<C_{thr}$: the local minimum of $\Delta\varepsilon_{lb} \approx -0.05$ at $C \approx 10^{-7}$ M coincides with a local minimum of $|\varphi_{lb}^{1.10^{-7}-4.10^{-7}m}|$ -- according to dielectrometry theory, for concentration ranges at which $\Delta\varepsilon < 0$, polar domains likely are lined up in low polar multipole structures, thus decreasing $\varepsilon$ of the solution compared to that of the solvent; the global maximum of $\Delta\varepsilon_{lb} = 1$ at $C \approx 10^{-10}$ M coincides with a global maximum of $|\varphi_{lb}^{1.10^{-7}-4.10^{-7}m}| \approx 12$ mV, which is attributable to polar domains organized in chain (ribbon) structures with the dipole moments arranged unidirectionally; the global minimum of $\Delta\varepsilon_{lb} \approx -1.5$ at $C \approx 10^{-14}$ M coincides with a local minimum in $|\varphi_{lb}^{1.10^{-7}-4.10^{-7}m}| \approx 4$ mV -- the global nature of this minimum of $\Delta\varepsilon_{lb}$ indicates inverse-parallel orientation of the polar domains at this concentration range. As to the agglomeration of $\text{CD}^{H_0}_{\text{elec}}$ into supra-CD\text{elec}\textsuperscript{H_0} at these extremums, we cite the local minimum of $D_{lb}^{1.10^{-7}-4.10^{-7}m} \approx 2.5 \times 10^{-7}$ m at $C \approx 10^{-7}$ M, the local minimum of $D_{lb}^{1.10^{-7}-4.10^{-7}m} \approx 2.7 \times 10^{-7}$ m at $C \approx 10^{-10}$ M and the global maximum of $D_{lb}^{1.10^{-7}-4.10^{-7}m} \approx 4.2 \times 10^{-7}$ m at $C \approx 10^{-14}$ M. The aforementioned $\Delta\varepsilon_{lb}$ and $D_{lb}^{1.10^{-7}-4.10^{-7}m}$ values suggest that for inverse-parallel oriented CD\text{rot}, supra-CD\text{elec}\textsuperscript{H_0} sizes are maximal. However, the opposite was observed for aqueous SDVSPL\textsuperscript{we-ne} of membranotropic amphiphilic calix[4]resorcinarene: maxima in its $D_{lb}^{1.10^{-7}-4.10^{-7}m}$ coincide with the polar domains mainly organizing in chain structures (Ryzhkina et al., 2012c). Hitherto, details of $\Delta\varepsilon(C)$ only were gathered for the SDVSPL\textsuperscript{we-ne} cited in this paragraph and theoretical aspects of CD\text{rot} orderings, CD\text{elec}\textsuperscript{H_0} agglomerations, their dependence on concentration and solute type has not been investigated; therefore research directed at studying these concentration dependencies is called for.

vii. As to the observed effects of the various QED domains on the electric conductivity ($\chi$) of SDVSPL\textsuperscript{we-ne}:

(a) For $C > C_{thr}$, we cannot yet explain the dependence of $\chi$ on $C$, i.e., $\chi(C)$. As noted above existing data is insufficient for assigning domains to CD\text{plasmas} IPD\text{plasma} or EDA\text{IPDplasma} micelles or other aggregate types. Hence attributing $\chi$ values to any of these is not yet doable.

(b) For $\approx 10^{-18}$ M $< C < C_{thr}$, Ryzhkina et al. (2011c, 2011d, 2012a, 2012c, 2012d, 2013) found: $\chi(C)$ for samples kept on the laboratory bench $[\chi_{lb}(C)]$ is much larger than $\chi(C)$ of samples kept in Permalloy containers $[\chi_{P}(C)]$. For example for aqueous potassium phenosan SDVSPL\textsuperscript{we-ne} at $C \approx 10^{-14}$ M $\chi_{lb} \approx 25$ $\mu$S/cm while $\chi_{P}$ is an order of magnitude smaller. $\chi_{P}$ very slowly decreases with concentration and typically is $\approx 2.5$ $\mu$S/cm (slightly larger than $\chi$ of double distilled water). Moreover, $|\varphi_{lb}^{1.10^{-7}-4.10^{-7}m}|$ and $\chi_{lb}(C)$ are significant statistical correlated -- an enhancement in $|\varphi_{lb}^{1.10^{-7}-4.10^{-7}m}|$ causes larger $\chi_{lb}(C)$ and $\sigma_{lb}(C)$. As to explanations for these phenomena:

1. $\chi_{lb}(C)>>\chi_{P}(C)$, together with paragraphs v-vi, evoke the inequality results from Permalloy destroying CD\text{rot} and CD\text{elec}\textsuperscript{H_0}. $\chi$ is an inverse function of intermolecular collisions. For $C < C_{thr}$ intermolecular collisions solely involve randomly moving $H_2O$ and solvated solutes. Recall that the $H_2O$ in the superfluidic CD\text{rot} or CD\text{elec} do not collide. Thus the transformation of these domains’ coherent oscillating $H_2O$ into randomly moving $H_2O$ (induced by the EMF screening) enhances the number of intermolecular collisions and thus reduc-
es $\chi$. Also the electric dipoles of $\text{CD}_{\text{rot}}$ and the clouds of quasi free electrons of $\text{CD}_{\text{elec}}^{H_{2}O}$ affect collisions of randomly moving $\text{H}_{2}\text{O}$ neighboring on $\text{CD}_{\text{rot}}$ (Yinnon and Yinnon, 2011, 2012; Yinnon and Elia, 2013).

2. $\chi_{\text{lb}}(C)$ being correlated to $\zeta_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}|\psi_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}|^{2}$ and related to $D_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}(C)$, $\Delta \sigma_{\text{lb}}(C)$ and $\sigma_{\text{lb}}(C)$, together with the strong concentration dependence of these variables, indicate domains rearrangements are reflected in $\chi$. However, the current fuzziness concerning the effects of $\text{CD}_{\text{rot}}$ orderings on $D_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}(C)$ and $\zeta_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}|\psi_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}|^{2}$ (see paragraph vi), hinders explaining these relations.

3. Paragraphs (1-2) imply modeling $\chi(C)$ for $C=C_{\text{thr}}$, $\text{SDVSPL}^{\text{we-ne}}$ requires adequate description of alternating electric field interactions with: randomly moving solvent and solvated solute molecules; as well as with the dipoles of $\text{CD}_{\text{rot}}$, $\text{EDA}_{\text{CDrot}}$ and the quasi free electron clouds of $\text{CD}_{\text{elec}}^{H_{2}O}$.

Experimental data cited in the above paragraphs i-vii and their analyses support most of the QED model of $\text{SDVSPL}^{\text{we-ne}}$’s aspects i-vii, respectively.

**Interactions between bio-systems and $\text{SDVSPL}^{\text{we-ne}}$ or $\text{SDVSASES}$**

$\sim 10^{-20}$ $M < C < \sim 10^{-10}$ M laboratory-bench-kept serial diluted vigorously shaken polar liquids of a wide variety (thousands) of bioactive compounds, in a reproducible quantified manner, affect bio-systems, e.g., bio-macromolecules, cells, organs, organisms or populations (Palmina et al., 2009; Konovalov et al., 2014a-c). The bioactivity of these solutions persists even when their concentrations are much lower than those of the bio-systems. Rhyzkina et al. (2010a, 2011b, 2013), and Konovalov et al. (2014a-c) observed: the bioactivity of these solutions disappears on screening by Permalloy; the concentration dependence of the bioactivity is related to the solutions’ electric conductivity dependence on concentration $\chi_{\text{lb}}(C)$; it also is related to the absolute value of the $\zeta$-potential dependence on concentration $\zeta_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}|\psi_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}|^{2}$ of the $D_{\text{lb}} \approx 1x10^{-7}$ m to $D_{\text{lb}} \approx 4x10^{-7}$ m sized domains present in these solutions. Thus evidently these domains play a role in the bioactivity. Contemplating the effects of $\text{SDVSPL}^{\text{we-ne}}$ and $\text{SDVSASES}$ on biosystems is hampered by the many unsolved puzzles pertaining to biochemical reactions. However, $\zeta_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}|\psi_{\text{lb}}^{1x10^{-7}-4x10^{-7}\text{m}}|^{2}$ provides a clue.

Most biochemical reactions are redox electron transfer reactions, involving bio-molecules with high electronic excitation energies. Electron transfer occurs over distances beyond van der Waals contact, i.e., direct donor-to-acceptor electronic interactions are negligible and customarily water is assumed to act as a go-between (Balabin et al., 2008). Since water molecules have high ionization energy (12.6 eV), as a matter of course these are not regarded as a source of nearly free electrons. Their usual conjectured roles include electron tunneling facilitation, solvation of counter-ions, dielectric screening, proton coupling.

Supra-$\text{CD}_{\text{rot}}^{<\text{supra-CD}_{\text{elec}}^{H_{2}O}>}$ stabilized at biological interfaces playing a central role in electron transfer was conjectured by Del Giudice et al. (2010, 2013). Water in biosystems can be considered interfacial water -- it is but a fraction of a micron from an interface (cell membranes, macromolecules, etc). The quasi free electrons of the supra-$\text{CD}_{\text{elec}}^{H_{2}O}$ in interfacial water constitute a pool of nearly free electrons. The superfluidity of $\text{CD}_{\text{elec}}^{H_{2}O}$ entails its quasi free electrons reside in a collective state with a narrowly (peV) spaced spectrum. The pool’s excited states persist for macroscopic times, i.e., a supra-$\text{CD}_{\text{elec}}^{H_{2}O}$ is an efficient energy storage device. A $\text{CD}_{\text{elec}}^{H_{2}O}$ attracts molecules containing in their spectrum a frequency close to one of its own, e.g., a bioactive molecule. This bioparticle becomes a guest participant in the coherent dynamics of the $\text{H}_{2}\text{O}$ constituting $\text{CD}_{\text{elec}}^{H_{2}O}$. It settles on the boundary of the
The difference in frequencies of the guest and the $CD_{\text{elec}}^{H_2O}$ perturbs the domain’s dynamics. Few guests do not harm their $CD_{\text{elec}}^{H_2O}$ but numerous guests wreck their host. Whenever the energy stored in supra-$CD_{\text{elec}}^{H_2O}$ matches the guest’s activation energy, energy discharge of the supra-$CD_{\text{elec}}^{H_2O}$ and onset of the chemical array occur simultaneously. With the $\sim 10^{-7}$ m diameter of $CD_{\text{elec}}^{H_2O}$, the $H_2O$ and quasi free electrons in supra-$CD_{\text{elec}}^{H_2O}$ all residing in collective states, QED possibly may elucidate biosystems’ fast electron transfer over long distances.

Experimental data supporting the last paragraph’s conjecture of Del Giudice et al. (2010, 2013) has not yet been presented. Our analyses of SDVSPL we-ne strengthen it. The relation between the concentration dependency of SDVSPL we-ne’s bioactivity and $|\zeta|_{lb}^{1x10^{-7} - 4x10^{-7} \text{m}}(C)$, together with paragraph’s vi’s attribution that quasi free electrons underlie $|\zeta|_{lb}^{2x10^{-1} - 4x10^{-1} \text{m}}$, evokes SDVSPL we-ne’s $CD_{\text{elec}}^{H_2O}$ with their pool of superfluidic quasi free electrons and their guest bioactive molecules influence bio-systems. For example, the $CD_{\text{elec}}^{H_2O}$ in SDVSPL we-ne together with their bioactive guests molecules might directly affect membranes or interact with their interfacial water’s $CD_{\text{elec}}^{H_2O}$. Indeed enhancement of bio-systems’ biological activity or plasmatic membranes’ lipid order parameter, induced by SDVSPL we-ne, was observed to depend on these liquids’ concentration in a manner similar to that of their $\chi_{lb}(C)$ and $|\zeta|_{lb}^{1x10^{-7} - 4x10^{-7} \text{m}}(C)$ (Palmina et al., 2009; Konovalov, 2013; Konovalov et al., 2014a-c). Moreover as mentioned above, the concentration at which numerous SDVSPL we-ne’s bioactivity, $|\zeta|_{lb}^{1x10^{-7} - 4x10^{-7} \text{m}}$, $\chi_{lb}$ and IR-SPBCF have extremums fall in small ranges ($\sim 10^{-9}$ M - $10^{-10}$ M; $\sim 10^{-13}$ M - $10^{-15}$ M). Guest bioactive molecules’ oscillations resonating with the coherent oscillations of $H_2O$ in $CD_{\text{elec}}^{H_2O}$, $CD_{\text{rot}}$ and [supra-$CD_{\text{rot}}^{<supra-CD_{\text{elec}}^{H_2O}>}$], and these bioactive molecules’ prevalence being low enough not to wreck their host, might underlie the extremums. As a first step for researching aforementioned conjecture, we study characteristics of $CD_{\text{elec}}^{H_2O}$ and [supra-$CD_{\text{rot}}^{<supra-CD_{\text{elec}}^{H_2O}>}$] adjacent to membranes (Yinnon et al., 2015c WATER Journal in press; Liu et al., 2015). In the current absence of detailed knowledge on interactions between biomolecules and $CD_{\text{elec}}^{H_2O}$ or $CD_{\text{rot}}$ their study too is called for.

Another conjecture for the bioactivity of SDVSPL we-ne and SDVSASES, forwarded by Pershin (2014), bases on the quantum differences between ortho- and para-$H_2O$ spin isomers. Pershin’s approach seemingly complements ours, i.e., magnetic moments of vortices in CDrot and quasi free electrons interacting with the $H_2O$ spin isomers likely affect these solutions’ properties. Hitherto, interactions between spin isomers and QED domains have not been studied and such studies are called for. While such interactions likely affect domains in SDVSPL we-ne and in SDVSASES, at least these cannot play a decisive role in CDrot formation, because these also form in non-aqueous serial diluted vigorously shaken solutions.

Conclusions

This paper shows that the in 2011 presented QED model for serial diluted solutions which were vigorously shaken after each dilution step enables consistent explanations also for recently observed characteristics. For example for the characteristics of molecular associates in serial diluted vigorously shaken polar liquids containing weak electrolytes or non-electrolytic compounds (SDVSPL we-ne) with concentrations down to $10^{-20}$ M. In the past the model explained various physicochemical properties of SDVSPL we-ne. The closely related QED model for serial diluted vigorously shaken aqueous solutions of strong electrolytes (SDVSAES) also has provided consistent explanations for many phenomena (Yinnon and Yinnon, 2011; Yinnon and Elia, 2013;
Yinnon and Liu, 2015b). Our above presented analyses of experimental results, in particular those of Konovalov and Ryzhkina (2014a), for the first time enabled verification of the following central features of the SDVSPLe-ne model:

a) Interactions between EMF and molecules mediate several types of association, resulting in presence of various types of domains in specific concentration regimes. Screening samples from EMF by placing them in Permalloy containers verified this feature.

b) The typical characteristics of three domain types, i.e., CDrot, CDplasma and CDH20, predicted by the model agree with observed ones. For example:

- Their sizes being of the order of 10^{-5} m, 10^{-6} m and 10^{-7} m, respectively, and their organization in supra-domains was demonstrated with DLS and AFM.
- The macroscopic times (1 - 18 h) required for their stabilization, which was demonstrated with kinetic measurements.
- The ferroelectric ordering of the solvent molecules constituting CDrot, endowing these domains with a permanent electric dipole moment, are reflected in dielectrometry and surface tension data. These domains were observed to agglomerate into supra-domains. Chain associates in which the dipole moments are more or less parallel oriented may compose these supra-CDrot. Multipole aggregates with the dipoles of CDrot "inverse-parallel" orientated, leading to formation of non-polar aggregates, were also observed.
- The dissipative dynamics of CDrot and CDH20 are reflected in the IR spectra pass band coefficient fluctuations of SDVSPLe-ne.
- The critical concentration (C_{CDrot crit}) below which 10^{-5} m sized CDrot can persist over macroscopic times in SDVSPLe-ne was identified with a combination of techniques, e.g., dielectrometry, DLS, screening samples from ambient EMF by placing them in Permalloy containers.
- CDH20 being negatively charged has been substantiated by microelectrophoresic measurements of their electrokinetic potential (ζ-potential).
- Stabilization of CDH20 or CDrot has been demonstrated with electric conductivity data, which reflect their superfluidic properties.

For one domain type, i.e., the ~10^{-6} m sized IPDplasma predicted to be present at 10^{-6} M<C<10^{-4} M in solution of weak electrolytes and non-electrolytes, we pointed out the kind of experiments required for unambiguous distinguishing these among the various types of observed domains. [Formation of IPDplasma in aqueous strong electrolytes has been verified, as discussed by Yinnon and Yinnon (2012), Yinnon and Liu (2015b)].

c) The QED model’s prediction that only in solutions with polar solvents, their preparation by serial dilutions and vigorous shaking after each dilutions step induces molecular association at very low concentrations is supported by the experimental findings of Ryzhkina et al. (2011b). In SDVSPLe-ne of α-Tocopherol dissolved in chloroform or dissolved in water they observed domains at 10^{-20} M<C<10^{-3} M. However, for SDVSPLe-ne of α-Tocopherol dissolved in the non-polar tetrachloride, they could not discern molecular association at such low concentrations.

d) Only in solutions of certain solute types, serial dilutions and vigorous shaking the liquid after each dilution step perpetuate presence of domains at very low concentrations, e.g., at 10^{-20} M<C<10^{-10} M. The model predicts that the required characteristic of the solute is that it has a sufficiently large permanent or induced electric dipole moment. Experiments indeed verified that only for certain solutes, their serial diluted vigorous shaken solutions contain molecular associates at very low concentrations.
(Konovalov, 2013). However, these solutes and their specific characteristics have not yet been listed in the literature.

All these verifications support an important result attained with the QED model of polar liquids. The model uncovered the dynamics causing serial diluted solutions which were vigorously shaken after each dilution step at ultra low concentrations to have characteristics differing from those predicted by the customary electrostatic theories. The features of the QED model of SDVSPL_{ne-se} substantiated in this paper and in previous ones, together with the corroborations of the QED model of SDVSASES published in previous articles, lead to the conclusion: “stabilization of CD_{rot} at C \approx C_{\text{crit}}^{CD_{rot}} is crucial for inducing the distinctive characteristics of SDVSPL_{ne-se} and SDVSASES at ultra low concentrations.” According to QED, CD_{rot} can get stabilized by entities with a sufficiently large asymmetric charge distribution, e.g., solvated solutes or molecular associates with a large permanent or induced electric dipole moment. Once such an entity stabilizes CD_{rot}, subsequent vigorous shaking excites these domains or breaks them up. Due to the ferroelectric ordering of the solvent molecules constituting CD_{rot}, excited CD_{rot} as well as their broken pieces also have an electric dipole moment, i.e., are electric dipole aggregates (EDA_{CD_{rot}}). Successive dilution, diminishes CD_{rot} and EDA_{CD_{rot}}. However, these domains are molecular associates with an electric dipole moment, and as such stabilize new CD_{rot}. Thus serial dilutions with vigorous shaking after each dilution step perpetuate presence of CD_{rot} after these first got stabilized at C \approx C_{\text{crit}}^{CD_{rot}}. In aqueous solutions CD_{rot} also may stabilize CD_{H_{2}O}^{H_{2}O} and supra-CD_{H_{2}O}^{supra}.

As to the characteristics of entities stabilizing CD_{rot} in serial diluted solutions, hitherto only for SDVSASES is there some experimental evidence. Below a solute type dependent transition concentration (C_{\text{trans}}^{IPD_{plasma}}), ions and the polar H_{2}O organize in IPD_{plasma}. Typically these IPD_{plasma} are present at \sim 10^{-6} \text{ M}< C< \sim 10^{-4} \text{ M}. These domains have no asymmetric charge distribution. However, excitation of IPD_{plasma} or their break up induced by vigorous shaking transforms IPD_{plasma} into molecular associates with an asymmetric charge distribution, i.e., these are electric dipole aggregates (EDA_{IPD_{plasma}}). Accordingly in SDVSASES, EDA_{IPD_{plasma}} stabilize CD_{rot} at C \approx C_{\text{crit}}^{CD_{rot}}. Such stabilization requires that the electrolyte solution is first diluted below C_{\text{trans}}^{IPD_{plasma}} and subsequently vigorously shaken after each additional dilution step. For SDVSPL_{we-ne} no sufficient experimental data exist for determining presence of IPD_{plasma} in dilute solutions, and their transformation to EDA_{IPD_{plasma}} induced by vigorous shaking. Moreover, for SDVSPL_{we-ne}, experimental data unambiguously verifying solutes with sufficiently large electric dipole moments stabilize CD_{rot} at C \approx C_{\text{crit}}^{CD_{rot}} is also lacking. The kinds of experiments required for revealing the presence of IPD_{plasma} are detailed in the discussion section.

The abovementioned implies that important qualitative aspects of the structure and physicochemical properties of SDVSPL_{ne-se} and SDVSASES have now been explained. As to future research, in addition to that detailed in the Discussion section, we point to the following desirable projects:

- Quantitative verification of the structural and physicochemical properties of SDVSPL_{ne-se} and SDVSASES predicted by QED.
- Research directed at elucidating the effects of SDVSPL_{ne-se} and SDVSASES on bio-systems;
- Deriving equations for physicochemical properties of liquids containing the various kinds of QED domains; computing the values of the physicochemical variables and showing these agree with measured ones.
Table 2: List of abbreviations in alphabetic order, followed by Greek symbols abbreviations.

<table>
<thead>
<tr>
<th>Abbreviations</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>AFM</td>
<td>Atomic force microscopy</td>
</tr>
<tr>
<td>C</td>
<td>Concentration</td>
</tr>
<tr>
<td>C&lt;sub&gt;crit&lt;/sub&gt;</td>
<td>Critical concentration</td>
</tr>
<tr>
<td>C&lt;sub&gt;CD-Dot&lt;/sub&gt;</td>
<td>Critical concentration below which CD&lt;sub&gt;Dot&lt;/sub&gt; may form</td>
</tr>
<tr>
<td>C&lt;sub&gt;CD-plasma&lt;/sub&gt;</td>
<td>Transition concentration for CD&lt;sub&gt;Plasma&lt;/sub&gt; formation</td>
</tr>
<tr>
<td>C&lt;sub&gt;IPD-plasma&lt;/sub&gt;</td>
<td>Transition concentration for IPD&lt;sub&gt;Plasma&lt;/sub&gt; formation</td>
</tr>
<tr>
<td>C&lt;sub&gt;crit&lt;/sub&gt;</td>
<td>Threshold concentration</td>
</tr>
<tr>
<td>CD</td>
<td>Coherence domain</td>
</tr>
<tr>
<td>CD&lt;sup&gt;H2O&lt;/sup&gt;</td>
<td>Coherence domain composed of coherent electronically excited water molecules</td>
</tr>
<tr>
<td>CD&lt;sub&gt;solv&lt;/sub&gt;</td>
<td>Coherence domain composed of few solvated solutes performing coherent plasma oscillation and numerous polar solvent molecules</td>
</tr>
<tr>
<td>CD&lt;sub&gt;iso&lt;/sub&gt;</td>
<td>Coherence domains of ferroelectric ordered polar solvent molecules</td>
</tr>
<tr>
<td>D</td>
<td>Effective hydrodynamic diameter of molecular associate</td>
</tr>
<tr>
<td>D&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Effective hydrodynamic diameter of molecular associates of samples kept on the laboratory bench</td>
</tr>
<tr>
<td>D&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Effective hydrodynamic diameter of molecular associates of samples kept in Permalloy containers</td>
</tr>
<tr>
<td>D&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Effective hydrodynamic diameter of 1x10&lt;sup&gt;-7&lt;/sup&gt; - 4x10&lt;sup&gt;-10&lt;/sup&gt; m sized molecular associates of samples kept on the laboratory bench</td>
</tr>
<tr>
<td>DLS</td>
<td>Dynamic light scattering</td>
</tr>
<tr>
<td>EDA&lt;sup&gt;Exe&lt;/sup&gt;</td>
<td>Excited or broken CD&lt;sub&gt;Dot&lt;/sub&gt; piece, which has an electric dipole moment and therefore is denoted electric dipole aggregate (EDA)</td>
</tr>
<tr>
<td>EDA&lt;sup&gt;Exe&lt;/sup&gt;</td>
<td>Excited or broken IPD&lt;sub&gt;Dot&lt;/sub&gt; piece, which has an electric dipole moment and therefore is denoted electric dipole aggregate (EDA)</td>
</tr>
<tr>
<td>EMF</td>
<td>Electro-magnetic fields</td>
</tr>
<tr>
<td>eV</td>
<td>Electron Volt</td>
</tr>
<tr>
<td>FIR</td>
<td>Far Infra Red</td>
</tr>
<tr>
<td>IPD&lt;sub&gt;solv&lt;/sub&gt;</td>
<td>In phase domains composed of few solvated solutes and numerous solvent molecules performing in phase plasma oscillation.</td>
</tr>
<tr>
<td>IR</td>
<td>Infra red</td>
</tr>
<tr>
<td>IR-SPBCF</td>
<td>Infra red spectra pass band coefficient fluctuations</td>
</tr>
<tr>
<td>pH&lt;sub&gt;b&lt;/sub&gt;</td>
<td>pH of samples kept at the laboratory bench</td>
</tr>
<tr>
<td>QED</td>
<td>Quantum electro-dynamics</td>
</tr>
<tr>
<td>SDVSASES</td>
<td>Serial diluted vigorous shaken aqueous strong electrolyte solution</td>
</tr>
<tr>
<td>SDVSPE&lt;sup&gt;ss&lt;/sup&gt;</td>
<td>Serial diluted vigorous shaken polar liquids of weak electrolytes or non-electrolytes</td>
</tr>
<tr>
<td>Supra-CD</td>
<td>Agglomerate of coherence domains</td>
</tr>
<tr>
<td>[Supra-CD&lt;sub&gt;Dot&lt;/sub&gt; - Supra-CD&lt;sub&gt;H2O&lt;/sub&gt;]&lt;sup&gt;&lt;sub&gt;b&lt;/sub&gt;&lt;/sup&gt;</td>
<td>Agglomerate of CD&lt;sub&gt;Dot&lt;/sub&gt; containing agglomerates of CD&lt;sub&gt;H2O&lt;/sub&gt;</td>
</tr>
<tr>
<td>ULC</td>
<td>Ultra low concentration</td>
</tr>
<tr>
<td>UV</td>
<td>Ultra-violet</td>
</tr>
<tr>
<td>ε&lt;sub&gt;c&lt;/sub&gt;</td>
<td>Dielectric permittivity</td>
</tr>
<tr>
<td>ε(C)</td>
<td>Dielectric permittivity as function of concentration</td>
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<tr>
<td>Δε(C)</td>
<td>Δε as function of C</td>
</tr>
<tr>
<td>Δε&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Δε of samples kept at the laboratory bench</td>
</tr>
<tr>
<td>Δε&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Δε for samples screened by Permalloy as function of concentration</td>
</tr>
<tr>
<td>γ</td>
<td>Electrokinetic potential of molecular associates in samples kept in Permalloy containers</td>
</tr>
<tr>
<td>ζ&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Electrokinetic potential of 1x10&lt;sup&gt;-7&lt;/sup&gt; - 4x10&lt;sup&gt;-10&lt;/sup&gt; m sized molecular associates in samples kept at the laboratory bench</td>
</tr>
<tr>
<td>ζ&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Absolute value of ζ&lt;sub&gt;b&lt;/sub&gt;</td>
</tr>
<tr>
<td>ζ&lt;sub&gt;b&lt;/sub&gt;</td>
<td>ζ as function of C</td>
</tr>
<tr>
<td>ζ&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Electrokinetic potential of molecular associates in Permalloy containers</td>
</tr>
<tr>
<td>χ</td>
<td>Electric conductivity in µS cm&lt;sup&gt;−1&lt;/sup&gt;</td>
</tr>
<tr>
<td>χ(C)</td>
<td>Electric conductivity as function of concentration</td>
</tr>
<tr>
<td>χ&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Electric conductivity of samples kept in Permalloy containers</td>
</tr>
<tr>
<td>δ&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Surface tension of samples kept at the laboratory bench</td>
</tr>
<tr>
<td>δ&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Surface tension of samples kept at the laboratory bench as function of concentration</td>
</tr>
<tr>
<td>δ&lt;sub&gt;b&lt;/sub&gt;</td>
<td>Surface tension of samples kept in Permalloy containers</td>
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</table>
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