EPSC Abstracts
Vol. 10, EPSC2015-540, 2015
European Planetary Science Congress 2015

Coherent-fields, their responsive colloids, and life's origins.

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Abstract

In living systems, evolvable sequence-encoded constraints control the incoming energy-matter flows, and are also sustained by their embedded flows/ processes. What's more, in such dynamic-organized liquid-state media, the flows can also produce novel materials/mechanisms. Thus, embedded processes of such media enable its spatiotemporal resilience via turnovers, as well as functional 'takeovers'. Further, the responsiveness of such constrained media to their environment enables adaptations, as they can mediate feedback between the changing environment & their embedded flows/processes. Now, the complexity of the constituent functional materials, make it very likely that they themselves emerged/got selected thanks to the creative properties of such dynamically constrained media. We have asked if such Maxwell-demon-like scenario could not be mimicked using other plausible ingredients to achieve similar ways of dissipative sustenance and coherent functioning. In particular, the potential of organizing coherent fields and their responsive anisotropic colloids to enhance the probability of life's emergence—akin to an adaptive transition—to a new way of evolving, seems promising. Note that pattern-sustenance in liquid state requires presence of the specific source that enabled it (c.f. spontaneously formed patterns). For example, external coherent heterogeneous fields (e.g. magnetic rocks) can act as sources both of 1) aperiodic information, and 2) useful energy, for inducing and sustaining (specific) structures of super-paramagnetic mineral colloids (via their Brownian-rotation) away-from-equilibrium, to access 3-way coupling between energy-information-matter in liquid-medium. Such dynamic functioning structures seem ideal for stable containment of bottom-up chemical systems; and similar scenario in the nano-science engineering area can help in design/tests.

1. Introduction

Iterations of random variation of genotype-- with judgement/selection of the resulting phenotype's fitness in its environment context, -- underlies Darwinian evolution. But, what could be the *raison d'être* of such magical evolving liquid-state organizations that can change their environment and be shaped by it? One possibility (supposed by the conventional synthetic bottom-up approach) —albeit discontinuous with life's evolution -- is that they emerged via independent disparate stages, and with somehow selected specific anisotropic building blocks, plus inexplicably harnessed disequilibrium sources producing some useful form of energy (to do work), all from passive host-media. For example, use of non-reconfigurable rock/crystal surfaces, thermal gels, and/or uncontrolled entrapped aqueous-spaces already sets bounds on their potential for controllable kinetics. The picture improves with viscous media, but these lack controlled order needed for functioning. It appears more life-like via mineral/lipid soft-matter aggregates, as dipolar anisotropic components can achieve liquid-crystal-like patterned states, with feedback-enabling response effects; however, patterns formed spontaneously (such as via lowering of temperature) lack the capacity to resist Brownian forces in the long run. A more interesting possibility comes about if one imagines the starting liquid-state host-medium—comprising dispersed mineral/organic soft-matter-- to be a robust field-controlled spatio-temporally-patterned one with a capacity to slowly build-up/integrate information, received over time [1]. In that case, like living media, it could transmit any tiny/major changes caused via environmental interactions to its embedded reactions, or vice-versa.

2. Discussion

What could be the anatomy of such an informational liquid medium coupled to a thermal bath? Firstly, being 'rich in information' requires a *subjective* outcome, in place of any one of many alternative possible objective outcomes, e.g. (independent agent-like) components need to have freedom to arrange themselves in maximum possible ways via some non-specific mode of interacting with each other, which is controllable via external influence [1]. To that end,

interplay of randomly orienting Brownian forces and dipolar forces with same order of magnitude (plus some short-range repulsive interaction) is facilitated at the nanoscale. And, thanks to the distributed nature of the controlling H-field, each thermally agitated responsive-particle --via its capacity to couple its magnetic & rotational d.o.f.s-- can act like an 'agent', influencing each other and their global interaction pattern. Indeed, feedback between the external and induced internally generated fields in the resulting aggregates (a challenging research subject) is also reminiscent of the feedback between descriptor (DNA) and executor (RNA, protein, etc) levels of constraints, in living systems. Note that diverse asymmetric configurations can be induced depending on the properties of the field (strength, intensity, direction, etc.) and of the particle's (susceptibility, solid-state properties, etc). Further, these structures are highly sensitive to environment-parameters (ionic strength of the medium, pH, temperature, etc). This suggests that in the same way as field-parameters are tuned to switch between different configurational states (with different network-properties) in the sector of technology, similar tuning/switching could have been realized in such naturally induced-configurations via environmental parameter changes. Again, the influence of H-fields on a membrane's elastic properties --via magnetic inclusions-- can enable control of shearing/merging of vesicles ([2]; c.f. uncontrolled bottom-up mode). Another scenario for field-control could be the use of liquid crystals (LCs) as host matrices for assembly of nanostructures (see [1] plus references). Organic matter associated with meteorites, despite heterogeneity, may also have propensity to form such phases. And, the findings that mineral colloids can also form liquid crystalline phases seem promising as they can combine the anisotropy and fluid properties of liquid crystals with the electronic and structural properties of minerals. To facilitate the formation and sustenance of such organic/mineral phases, it could be useful to draw from studies on artificial magnetic phases like ferro-nematics (see Brochard and deGennes (1970) cited in [1]. The main point is that the strong orientational coupling between dispersed magnetic particles and their host liquid crystalline matrix helps to enhance the magnetic property of the system; the presence of the dispersed phase helps to assist alignment of the LC phase, plus control the configuration of the whole system, via weak external fields. Indeed, latest liquid crystalline hybrid systems combine the solid-state properties (optical, magnetic, catalytic, etc) of inorganic colloid inclusions with the positional-cum-orientational order of the lyotropic matrix in order to gain control on the fluid system's configuration at both micro- and macroscopic levels [3]. The physical basis of the coupling between the inclusions and the host-mesophase, facilitates the extension of such scenario based on organic phases to mineral ones; to that end, appropriate tests would be desirable. We urge Systems-chemistry initiatives to consider such externally-tunable patterned media (combining the best of ordered solid and fluid liquid worlds), with environment-sensitivity and low water activity; enabling access to oriented confinement of organics sterically–coupled to the components; having affinity-column-like feature, permitting removal of wastes; capacity to transport under disequilibrium conditions (and provide energy in useful form, electrons, spins); enabling complementary molecular interactions, plus interplay of macroscopic control and microscopic randomness; and how such network properties can help select for equivalents [see 1].

3. Summary and Conclusions

Coherent fields and their responsive liquid systems could serve as naturally feasible environment-sensitive functional cell-analogs, to their embedded fledgling prebiotic chemical systems, and enhance the aposteriori probability of life's origins. Indeed, the scenario of induced diverse possible cooperative-configurational states, also make for a (analog-like) primitive language (c.f. insights of Howard Pattee) wherein the associated network properties provide the "functional meaning". Sure enough, a sustained spatiotemporal organization in liquid state is crucial for storage-transmission-processing of each of the three types of environment inputs: matter, energy sources, and information, in any location.

References

[1] Mitra-Delmotte, G., and Mitra, A.N.: Field-Control, Phase-Transitions, and Life's Emergence, Frontiers in Physiology, Vol. 3, p 366, 2012.

[2] Petrichenko, O., Erglis, K., C¯ebers, A., Plotniece, A., Pajuste, K., B´ealle, G., M´enager, Ch., Dubois E., and Perzynski, R. (2013) Bilayer properties of giant magnetic liposomes formed by cationic pyridine amphiphile and probed by active deformation under magnetic forces. Eur. Phys. J. E 36, 9

[3] Constantin, D., and Davidson, P. (2014) Lamellar Lα mesophases doped with inorganic nanoparticles. Chem. Phys. Chem. 15, 1270−1282