How molecules in cells "find" one another and organize into structures?

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Abstract

How molecules in cells "find" one another and organize into structures is an old problem of biology. Now the group led by Amy S. Gladfelter has made experimental progress in this problem. It is reported that RNA molecules recognize each other to condense into the same droplet due to the specific 3D shapes that the molecules assume. Molecules with complementary base pairing can find each other and only similar RNAs condense on same droplet. This brings in mind DNA replication, transcription and translation. Furthermore, the same proteins that form liquid droplets in healthy cells, solidify in diseases like neurodegenerative disorders.

Some kind of phase transition is involved with the process but what brings the molecules together remains still a mystery. The TGD based solution of this mystery is one of the first applications of the notion of many-sheeted space-time in biology, and relies on the notion of magnetic flux tubes connecting molecules to form networks.

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1 Introduction

The title of the popular article "How molecules in cells 'find' one another and organize into structures?" (see http://tinyurl.com/ydbznknn) expresses an old problem of biology. Now the group led by Amy S. Gladfelter has made experimental progress in this problem. The work has been published in Science [I1] (see http://tinyurl.com/ybwyugho).

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Some kind of phase transition is involved with the process but what brings the molecules together remains still a mystery. The TGD based solution of this mystery is one of the first applications of the notion of many-sheeted space-time in biology, and relies on the notion of magnetic flux tubes connecting molecules to form networks.

2 TGD based model for the findings

Consider first the TGD based model about condensed and living matter. As a matter fact, the core of this model applies in all scales. What is new is there are not only particles but also bonds connecting them. In TGD they are flux tubes which can carry dark particles with nonstandard

value $h_{eff}/h = n$ of Planck constant. In ER-EPR approach in fashion they would be wormholes connecting distance space-time regions. In this case the problem is instability: wormholes pinch and split. In TGD monopole magnetic flux takes care of the stability topologically.

The flux tube networks occur in all scales but especially important are biological length scales.

1. In chemistry the flux tubes are associated with valence bonds and hydrogen bonds [L4] (see `http://tinyurl.com/ycg94xpl`). In biology genetic code would be realized as dark nuclei formed by sequences of dark protons at magnetic flux tubes. Also RNA, amino-acids, and even tRNA could have dark counterparts of this kind [L1] (see `http://tinyurl.com/jgfjlbe`). Dark variants of biomolecules would serve as templates for their ordinary variants also at the level of dynamics. Biochemistry would be shadow dynamics dictated to high degree by the dark matter at flux tubes.

2. Dark valence bonds can have quite long length and the outcome is entangled tensor net [L3](see `http://tinyurl.com/y9kwnqfa`). These neuronal nets serve as correlates for cognitive mental images in brain (see `http://tinyurl.com/yczv2o5b`) emotional mental images in body [L5] (see `http://tinyurl.com/ydhxen4g`). Dark photons propagating along flux tubes (more precisely topological light rays parallel to them) would be the fundamental communication mechanism [K3] (see `http://tinyurl.com/ydx9dq6x`). Transmitters and nerve pulses would only change the connectedness properties of these nets.

The topological dynamics of flux tubes has two basic mechanisms (I have discussed this dynamics from the point of view of AI [L2] (see `http://tinyurl.com/y75246rk`).

1. Reconnection of flux tubes serves is the first basic mechanism in the dynamics of flux tube networks and would give among other things rise to neural nets. The connection between neurons would correspond basically to flux tube pair which can split by reconnection. Also two flux tube pairs can reconnect forming Y shaped structures. Flux tube pairs could be quite generally associated with long dark hydrogen bonds scaled up by $h_{eff}/h = n$ from their ordinary lengths. Flux tube pairs would carry besides dark protons also supra phases formed by the lone electron pairs associated quite generally with hydrogen bonding atoms. Also dark ions could appear at flux tubes.

   Biomolecules would have flux loops continually scanning the environment and reconnecting if they meet another flux loop. This however requires that magnetic field strengths are same at the two loops so that a resonance is achieved at level of dark photon communications. This makes possible recognition by cyclotron frequency spectrum serving as signature of the magnetic body of the molecule.

   Water memory [K2] (see `http://tinyurl.com/ycqy837a`) would rely on this recognition mechanism based on cyclotron frequencies and also immune system would use it at basic level (here one cannot avoid saying something about homeopathy although I know that this spoils the day of the skeptic: the same mechanism would be involved also with it). For instance, dark DNA strand accompanying ordinary DNA and dark RNA molecules find each other by this mechanism (see `http://tinyurl.com/yalny39x`). Same applies to other reactions such as replication and translation .

2. Shortening of the flux tubes h_{eff}/h reducing phase transition is second basic mechanism explaining how biomolecules can find each other in dense molecular soup. It is essential that the magnetic fields at flux tubes are nearly the same for the reconnection to form. A more refined model for the shortening involves two steps: reconnection of flux tubes leading to a formation of flux tube pair between molecules and shortening by h_{eff}/h reducing phase transition.

Also ordinary condensed matter phase transitions involve change of the topology of flux tube networks and the model for it allows to put the findings described in the article in TGD perspective.

1. Quite recently I wrote an article [L6] (see `http://tinyurl.com/ydhknc2c`) about a solution of two old problems of hydro-thermodynamics: the behavior of liquid-gas system in the critical region not consistent with the predictions of statistical mechanics (known already at

times of Maxwell!) and the behavior of water above freezing point and in freezing. Dark flux tubes carrying dark protons and possibly electronic Cooper pairs made from so called lone electron pairs characterizing atoms forming hydrogen bonds.

2. The phase transition from gas to liquid occurs when the number of flux tubes per molecule is high enough. At criticality both phases are in mechanical equilibrium - same pressure. Most interestingly, in solidification the large h_{eff} flux tubes transform to ordinary ones and liberate energy: this explains anomalously high latent heats of water and ammonia. The loss of large h_{eff} flux tubes however reduces "IQ" of the system.

The phase transitions changing the connectedness of the flux tube networks are fundamental in TGD inspired quantum biology.

1. Sol-gel transition would correspond to this kind of biological phase transitions. Protein folding [K1] (see `http://tinyurl.com/y9lqmtea`) - kind of freezing of protein making it biologically inactive - and unfolding would be second basic example of this transition. The freezing would involve formation of flux tube bonds between points of linear protein and assignable to hydrogen bonds. External perturbations induce melting of the proteins and they become biologically active as the value of $h_{eff}/h = n$ characterizing their maximal possible entanglement negentropy content (molecular IQ) increases. External perturbation feeds in energy acting as metabolic energy. I have called this period molecular summer.

2. Solidification of proteins reducing is reported to be associated with diseases such neurodegenerative disorders. In TGD picture this would reduce the molecular IQ since the ability of system to generate negentropy would be reduced when $h_{eff}$for the flux tubes decreases to its ordinary value. What brings molecules together is not understood and TGD provides the explanation as h_{eff} reducing phase transition for flux tube pairs.

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