Revolution in chemistry

June 3, 2021

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Abstract

This article was inspired by a popular article telling about a revolution taking place in chemistry. New kinds of chemical bonds have been identified and David Brown has proposed an amazingly simple, predictive theory of chemical bonds involving as basic notions valence strength as valence charge per bond and the electric flux of the chemical bond.

This conforms with the TGD view about new chemistry. TGD inspires the proposal that valence bonds have non-standard value of the effective Planck constant h_{eff} labelling phases of ordinary matter behaving like dark matter. The model makes it possible to understand valence bond energies. TGD also leads to a description of chemical bonds in terms of space-time topology associating them with magnetic flux tubes. Therefore it is interesting to look at the new findings in the TGD framework.

1 Introduction

Moore Thaung gave a link to a very interesting article with title "Rules of attraction: Strange chemical bonds that defy the textbooks" (https://cutt.ly/Jner49B) telling of new chemistry. Unfortunately, a subscription to New Scientist was required. It was however easy to find in the web several popular articles telling about the changing views concerning chemical bonds.

The article "This weird chemical bond acts like a mash-up of hydrogen and covalent bonds" (https://cutt.ly/Snetr52) tells about hybrids of hydrogen and and covalent bonds. For short bond lengths these bonds become strong valence bonds and for long bond lengths weak hydrogen bonds which can even have length of 3 Angstrom.

The article "Strange bonds entirely new to chemists predicted in ammonia hydrides" (https://cutt.ly/1netzra) tells that ammonium NH_3 can form in the presence of hydrogen in very high pressure an exotic compound NH_7, which can decay to $NH_4^+ + H_2 + H^-$. NH_4^+ is also exotic.

The article "Sticking together: Another look at chemical bonds and bonding" https://cutt.ly/cnetPvG discusses the theory of chemical bonds proposed by Prof. David Brown, which has turned out to be very successful.

2 Two theoretical views about chemical bonds

In the following the bond theory of David Brown and the TGD view about chemical bonds are discussed and compared.

2.1 The bond theory of David Brown

The bond theory of David Brown is published as an article with title "Another look at bonds and bonding"in Structural Chemistry 31(1), 2019 [D1] (`https://cutt.ly/eneociZ`).

1. The theory involves the notion of electric flux as a purely classical element. The delocalization of valence electrons is of course a non-classical element and one can argue that this aspect is not well-understood in standard chemistry. In the TGD framework, the counterpart of electric flux is a flux tube carrying magnetic flux, which can be monopole flux. The tube can also carry an electric flux and a simple modification of purely magnetic flux tubes gives tubes carrying also an electric flux.

2. The key concept besides the notions of valence defined as the number N_v of valence electrons belonging to bonds, and the number of valence bonds N_b, is valence strength defined as $S_v \equiv N_v/N_b$. The total electric flux is the sum of fluxes assignable to the bonds and equals to the total electric charge -N_ve of valence electrons.

   By flux conservation, the electric fluxes at the ends of a given bond are opposite and this gives a strong constraint on the model. This condition is new from the point of standard bond theory and is purely classical.

3. The configurations with minimum energy are expected to be symmetric. In this case, the electric fluxes for the bonds are expected to be identical and proportional to the common bond strength.

   (a) An important implication of flux conservation in the symmetric case is that the valence strengths must be the same for bonded atoms. This condition excludes a large number of candidates.

   (b) If N_b is larger than N_v, the flux is fractional. This would represent an exotic situation. An interesting question is whether the flux could correspond to a quark pair or two quark pairs possible in the TGD framework in long scales. The idea that atoms could involve quarks looks of course rather outlandish from the standard model perspective. In this case the flux would be 1/3:rd or 2/3:rd of the flux associated with a single valence electron.

4. The model works for many kinds of bonds, and is claimed to work even for hydrogen bonds, and can be used to predict possible bonding structures. What is remarkable, that the notion of conserved electric flux assignable to chemical bonds resonates with the TGD view that non-trivial space-time topology behind the notion of flux tube is directly visible at the level of chemistry.

2.2 TGD view about chemical bonds

I remember the time when I realized that TGD suggests a description of the chemical bond in terms of the space-time topology. Could chemistry books be wrong, was the question, which I barely dared to articulate.

Gradually I learned that chemistry books do not really allow any deeper understanding of chemical bonds. One just says that they follow from Schodinger equation but computational complexity prevents proving this.

2.2.1 The TGD based view about valence bonds

TGD indeed implies a revolution in chemistry. Chemical bonds are accompanied by flux tubes possibly carrying dark particles with effective Planck constant $h_{eff} = h_0 > h = 6h_0$. Valence electrons of the less electronegative atom would get to the flux tube and become dark. This leads to a model of valence bonds [L2] predicting that the value of $h_{eff}/h_0 = n$ increases as one moves to the right along the row of the periodic table. This implies a delocalization of the valence electrons to longer scale scaling like h_{eff}^2 for the Bohr model and this is essential for the delocalization. This delocalization would be essential for chemistry of valence bonds and for biochemistry in particular. In metals delocalization would occur in the scale of lattice.

Also $h_{eff} < h$ bonds are in principle possible. Randell Mills has found evidence for a variant of hydrogen for which energies are scaled by a factor 1/4: this would mean $h_{eff} = h/2$ [D4] [L1].

The strange disappearance of the valence electrons of some transition metals in heating has been also known for decades [D3, L3] [L3]: heating would provide the energy needed to increase h_{eff} for valence electrons so that they become dark relative to us? Note that in TGD based biology metabolic energy would be used to increase h_{eff}, which serves as a kind of universal IQ as a measure of algebraic complexity.

An interesting possibility is that in the past scaled down atoms with $h_{eff} = h/2$ have existed [L5]. Could they correspond to most of the dark matter, the primordial dark matter? In the same article, it is also proposed that the Cambrian explosion involving a dramatic leap in biological evolution involved a phase transition in the Earth's scale doubling the radius of the "atomic" flux tubes with thickness of order atomic scale or order 1 Angstrom.

The presence of the "atomic" flux tubes makes it possible to understand the scale of atoms which depends only weakly on atoms although the Bohr radii of valence electrons are typically considerably smaller than atomic scale. The doubling of the flux tube radius by a factor two would have induced the doubling of the atomic size scale. This would have induced the doubling of h_{eff} for valence electrons. This phase transition would have led to the emergence of biochemistry.

2.2.2 Hydrogen bonds in the TGD framework

The popular article (`https://cutt.ly/Jner49B`) also mentions bonds without electrons. These bonds would make possible entanglement between atoms.

Hydrogen bond is an example of non-valence bond. Hydrogen bonds are special in that they can be as long as 3 Angstroms. The theory proposed by Brown would describe hydrogen bonds in terms of electron's delocalization.

In TGD framework it would be a proton that becomes dark delocalized to a flux tube accompanying the hydrogen bond, and has therefore $h_{eff} > h$ [L6]. In water one could have a spectrum of h_{eff} values with various bond lengths and this would give water its very special properties [L4]. Even flux tubes without any particles but serving as topological space-time correlates and even prerequisistes of entanglement between atoms are possible.

The hydrogen atom can form a bond between two atoms. Usually, the hydrogen forms a hydrogen bond with the first atom and valence bond with the second atom. This applies for large distances for which hydrogen bond is weak. At short distances hydrogen bond becomes stronger and it has been found that hybrids of hydrogen- and valence bonds between between two fluorine atoms - hydrogen-mediated chemical bonds - have been observed (`https://cutt.ly/Snetr52`).

In the TGD framework, the hybrids could be understood as a delocalization of both electron and proton to the two bonds involved. For short bond lengths, the proton would not be delocalized and for long bond lengths the electron would not be delocalized.

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