

%\begin{abstract}

In this chapter various TGD based ideas related to the role of super-conductivity in bio-systems are studied. TGD inspired theory of consciousness provides several motivations for this.

\vm{\it 1. Empirical evidence for high T_c superconductivity in bio-systems} \vm

There is evidence for super-conductivity in bio-systems. DNA should be insulator but under some circumstances it becomes conductor and perhaps even high T_c quantum critical super-conductor. Also evidence for Josephson effect has been reported. The so called ORMEs patented by Hudson are claimed to behave like superconductors: unfortunately the academic world has not taken these claims seriously enough to test them. The claimed properties of ORMEs conform with high quantum critical T_c super-conductivity and superfluidity. The strange findings about the strange quantal behavior of ionic currents through cell membranes suggest the presence of ionic supra currents.

\vm {\it 2. Model for high T_c superconductivity} \vm

A model for high T_c super-conductivity as quantum critical phenomenon is developed. The relies on the notions of quantum criticality, dynamical quantized Planck constant requiring a generalization of the 8-D imbedding space to a book like structure, and many-sheeted space-time. In particular, the notion of magnetic flux tube as a carrier of supra current of central concept.

With a sufficient amount of twisting and weaving these basic ideas one ends up to concrete model for high T_c superconductors as quantum critical superconductors consistent with the qualitative facts that I am personally aware. The following minimal model looks the most realistic option found hitherto.

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\item The general idea is that magnetic flux tubes are carriers of supra currents. In anti-ferromagnetic phases these flux tube structures form small closed loops so that the system behaves as an insulator. Some mechanism leading to a formation of long flux tubes must exist. Doping creates holes located around stripes, which become positively charged and attract electrons to the flux tubes.

\item The basic mechanism for the formation of Cooper pairs is simple. Magnetic flux tubes would be carriers of dark particles and magnetic fields would be crucial for super-conductivity. Two parallel flux tubes carrying magnetic fluxes in opposite directions is the simplest candidate for super-conducting system. This conforms with the observation that antiferromagnetism is somehow crucial for high temperature super-conductivity. The spin interaction energy is proportional to Planck constant and can be above thermal energy: if the hypothesis that dark cyclotron energy spectrum is universal is accepted, then the energies would be in bio-photon range and high temperature super-conductivity is obtained. If fluxes are parallel spin $S=1$ Cooper pairs are stable. $L=2$ states are in question since the members of the pair are at different flux tubes.

\item The higher critical temperature T_{c1} corresponds to a formation local configurations of parallel spins assigned to the holes of stripes giving rise to a local dipole fields with size scale of the order of the length of the stripe. Conducting electrons form Cooper pairs at the magnetic flux tube structures associated with these dipole fields. The elongated structure of the dipoles favors angular momentum $L=2$ for the pairs. The presence of magnetic field favors Cooper pairs with spin $S=1$.

\item Stripes can be seen as 1-D metals with delocalized electrons. The interaction responsible for the energy gap corresponds to the

transversal oscillations of the magnetic flux tubes inducing oscillations of the nuclei of the stripe. These transverse phonons have spin and their exchange is a good candidate for the interaction giving rise to a mass gap. This could explain the BCS type aspects of high T_c super-conductivity.

\item Above T_c supra currents are possible only in the length scale of the flux tubes of the dipoles which is of the order of stripe length. The reconnections between neighboring flux tube structures induced by the transverse fluctuations give rise to longer flux tubes structures making possible finite conductivity. These occur with certain temperature dependent probability $p(T,L)$ depending on temperature and distance L between the stripes. By criticality $p(T,L)$ depends on the dimensionless variable $x=TL/\hbar$ only: $p=p(x)$. At critical temperature T_c transverse fluctuations have large amplitude and makes $p(x_c)$ so large that very long flux tubes are created and supra currents can run. The phenomenon is completely analogous to percolation.

\item The critical temperature $T_c= x_c\hbar/L$ is predicted to be proportional to \hbar and inversely proportional to L (, which is indeed to be the case). If flux tubes correspond to a large value of \hbar , one can understand the high value of T_c . Both Cooper pairs and magnetic flux tube structures represent dark matter in TGD sense.

\item The model allows to interpret the characteristic spectral lines in terms of the excitation energy of the transversal fluctuations and gap energy of the Cooper pair. The observed 50 meV threshold for the onset of photon absorption suggests that below T_c also $S=0$ Cooper pairs are possible and have gap energy about 9 meV whereas $S=1$ Cooper pairs would have gap energy about 27 meV. The flux tube model indeed predicts that $S=0$ Cooper pairs become stable below T_c since they cannot anymore

transform to $S=1$ pairs. Their presence could explain the BCS type aspects of high T_c superconductivity. The estimate for $\hbar/\hbar_0 = r$ from critical temperature T_{c1} is about $r=3$ contrary to the original expectations inspired by the model of living system as a superconductor suggesting much higher value. An unexpected prediction is that coherence length is actually r times longer than the coherence length predicted by conventional theory so that type I superconductor could be in question with stripes serving as duals for the defects of type I superconductor in nearly critical magnetic field replaced now by ferromagnetic phase.

At qualitative level the model explains various strange features of high T_c superconductors. One can understand the high value of T_c and ambivalent character of high T_c superconductors, the existence of pseudogap and scalings laws for observables above T_c , the role of stripes and doping and the existence of a critical doping, etc...

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\vm {\it 3. The model for superconductivity in living matter} \vm

The model for high T_c superconductivity was inspired by the model of bio-superconductivity in which the flux tubes of magnetic fields are carriers of supra currents and the large value of Planck constant guarantees that gap energy and critical temperature are high enough. The transversal fluctuations of flux tubes provide the counterpart of phonons generating energy gap. Besides dark Cooper pairs also the Bose-Einstein condensates of dark bosonic ions define candidates for superconducting phases provided that the gap energies in longitudinal and transversal magnetic degrees of freedom are high enough. High enough values of Planck constant can guarantee this.