Contrary to the original expectations, TGD seems to allow a generalization of the space-time super-symmetry. This became clear with the increased understanding of the K\"ahler-Dirac action. The introduction of a measurement interaction term to the action allows to understand how stringy propagator results and provides profound insights about physics predicted by TGD.

The appearance of the momentum (and possibly also color quantum numbers) in the measurement interaction couples space-time degrees of freedom to quantum numbers and allows also to define SUSY algebra at fundamental level as anti-commutation relations of fermionic oscillator operators. Depending on the situation a finite-dimensional SUSY algebra or the fermionic part of super-conformal algebra with an infinite number of oscillator operators results. The addition of a fermion in particular mode would define particular super-symmetry. Zero energy ontology implies that fermions as wormhole throats correspond to chiral super-fields assignable to positive or negative energy SUSY algebra whereas bosons as wormhole contacts with two throats correspond to the direct sum of positive and negative energy algebra and fields which are chiral or antichiral with respect to both positive and negative energy theta parameters. This super-symmetry is badly broken due to the dynamics of the K\"ahler-Dirac operator which also mixes M^4 chiralities inducing massivation. Since righthanded neutrino has no electro-weak couplings the breaking of the corresponding super-symmetry should be weakest.

The question is whether this SUSY has a realization as a SUSY algebra at space-time level and whether the QFT limit of TGD could be formulated as a generalization of SUSY QFT. There are several problems involved.

\begin{enumerate}

\item In TGD framework super-symmetry means addition of fermion to the state and since the number of spinor modes is larger states with large spin and fermion numbers are obtained. This picture does not fit to the standard view about super-symmetry. In particular, the identification of theta parameters as Majorana spinors and super-charges as Hermitian operators is not possible.

\item The belief that Majorana spinors are somehow an intrinsic aspect of super-symmetry is however only a belief. Weyl spinors meaning complex theta parameters are also possible. Theta parameters can also carry fermion number meaning only the supercharges carry fermion number and are non-hermitian. The general classification of super-symmetric theories indeed demonstrates that for $D=8$ Weyl spinors and complex and non-hermitian super-charges are possible. The original motivation for Majorana spinors might come from MSSM assuming that right handed neutrino does not exist. This belief might have also led to string theories in D=10 and D=11 as the only possible candidates for TOE after it turned out that chiral anomalies cancel.

\item The massivation of particles is basic problem of both SUSYs and twistor approach. The fact that particles which are massive in M^4 sense can be interpreted as massless particles in $M^4\times CP_2$ suggests a manner to understand super-symmetry breaking and massivation in TGD framework. The octonionic realization of twistors is one possibility in this framework and quaternionicity condition guaranteeing associativity leads to twistors which are almost equivalent with ordinary 4-D twistors.

\item The first approach is based on an approximation assuming only the super-multiplets generated by right-handed neutrino or both right-handed neutrino and its antineutrino. The assumption that right-handed neutrino has fermion number opposite to that of the fermion associated with the wormhole throat implies that bosons correspond to ${\cal N}=(1,1)$ SUSY and fermions to ${\cal N}=1$ SUSY identifiable also as a short representation of ${\cal N}=(1,1)$ SUSY algebra trivial with respect to positive or negative energy algebra. This means a deviation from the standard view but the standard SUSY gauge theory formalism seems to apply in this case.

\item A more ambitious approach would put the modes of induced spinor fields up to some cutoff into super-multiplets. At the level next to the one described above the lowest modes of the induced spinor fields would be included. The very large value of ${\cal N}$ means that ${\cal N\leq 32}$ SUSY cannot define the QFT limit of TGD for higher cutoffs. One must generalize SUSYs gauge theories to arbitrary value of ${\cal N}$ but there are reasons to expect that the formalism becomes rather complex. More ambitious approach working at TGD however suggest a more general manner to avoid this problem.

\begin{enumerate} \item One of the key predictions of TGD is that gauge bosons and Higgs can be regarded as bound states of fermion and antifermion located at opposite throats of a wormhole contact. This implies bosonic emergence meaning that it QFT limit can be defined in terms of Dirac action. The resulting theory was discussed in detail in \cite{allb}{emergence} and it was shown that   bosonic propagators and vertices can be constructed as fermionic loops so that all coupling constant follow as predictions. One must however pose cutoffs in mass squared and hyperbolic angle assignable to the momenta of fermions appearing in the loops in order to obtain finite theory and to avoid massivation of bosons. The resulting coupling constant evolution is consistent with low energy phenomenology if the cutoffs in hyperbolic angle as a function of p-adic length scale is chosen suitably.

\item The generalization of bosonic emergence that the TGD
counterpart of
SUSY is obtained by the replacement of Dirac action with action for
chiral
super-field coupled to vector field as the action defining the
theory so
that the propagators of bosons and all their super-counterparts
would
emerge as fermionic loops.

\item The huge super-symmetries give excellent hopes about the
cancelation
of infinities so that this approach would work even without the
cutoffs in
mass squared and hyperbolic angle assignable to the momenta of
fermions
appearing in the loops. Cutoffs have a physical motivation in zero
energy
ontology but it could be an excellent approximation to take them to
infinity. Alternatively, super-symmetric dynamics provides cutoffs
dynamically. \end{enumerate}

\item The condition that ${\cal N}=\infty$ variants for chiral and
vector
superfields exist fixes completely the identification of these
fields in
zero energy ontology.

\begin{enumerate} \item In this framework chiral fields are
generalizations of induced spinor fields and vector fields those of
gauge
potentials obtained by replacing them with their super-space
counterparts.
Chiral condition reduces to analyticity in theta parameters thanks
to the
different definition of hermitian conjugation in zero energy
ontology
(θ is mapped to a derivative with respect to theta rather
than to
$\overline{\theta}$) and conjugated super-field acts on the product
of all
theta parameters.

\item Chiral action is a straightforward generalization of the Dirac
action
coupled to gauge potentials. The counterpart of YM action can
emerge only
radiatively as an effective action so that the notion emergence is
now
unavoidable and indeed basic prediction of TGD.

\item The propagators associated with the monomials of n theta parameters behave as $1/p^n$ so that only $J=0,1/2,1$ states propagate in normal manner and correspond to normal particles. The presence of monomials with number of thetas higher than 2 is necessary for the propagation of bosons since by the standard argument fermion and scalar loops cancel each other by super-symmetry. This picture conforms with the identification of graviton as a bound state of wormhole throats at opposite ends of string like object.

\item This formulation allows also to use K\"ahler-Dirac gamma matrices in the measurement interaction defining the counterpart of super variant of Dirac operator. Poincare invariance is not lost since momenta and color charges act on the tip of CD rather than the coordinates of the space-time sheet. Hence what is usually regarded as a quantum theory in the background defined by classical fields follows as exact theory. This feeds all data about space-time sheet associated with the maximum of K\"ahler function. In this approach WCW as a K\"ahler manifold is replaced by a cartesian power of CP_2, which is indeed quaternionic K\"ahler manifold. The replacement of light-like 3-surfaces with number theoretic braids when finite measurement resolution is introduced, leads to a similar replacement.

\item Quantum TGD as a \blockquote{complex square root} of thermodynamics approach suggests that one should take a superposition of the amplitudes defined by the points of a coherence region (identified in terms of the slicing associated with a given wormhole throat) by weighting the points with the K\"ahler action density. The situation would be highly analogous to a spin glass system since the K\"ahler-Dirac gamma matrices defining the propagators would be analogous to the parameters of spin glass Hamiltonian allowed to have a spatial dependence. This would predict the proportionality of the coupling strengths to K\"ahler coupling strength and bring in the dependence on the size of CD coming as a power of 2 and give rise to p-adic coupling constant evolution. Since TGD Universe is analogous to 4-D spin glass, also a sum over different preferred extremals assignable to a given coherence regions and weighted by $exp(K)$ is probably needed.

\item In TGD Universe graviton is necessarily a bi-local object and the emission and absorption of graviton are bi-local processes involving two wormhole contacts: a pair of particles rather than single particle emits graviton. This is definitely something new and defies a description in terms of QFT limit using point like particles. Graviton like states would be entangled states of vector bosons at both ends of stringy curve so that gravitation could be regarded as a square of YM interactions in rather concrete sense. The notion of emergence would suggest that graviton propagator is defined by a bosonic loop. Since bosonic loop is dimensionless, IR cutoff defined by the largest CD present must be actively involved. At QFT limit one can hope a description as a bi-local process using a bi-local generalization of the QFT limit. It turns out that surprisingly simple candidate for the bi-local action exists.

This statement has become somewhat misleading. It has turned out that all elementary particle in TGD framework are bi-local objects: one can assign to them both closed magnetic flux tubes behaving like strings and closed strings carrying fermion number. For other elementary particles than graviton second wormhole contact carries only neutrino pair neutralizing electroweak-isospin so that above weak scale they correspond to single em charged wormhole contact.

\end{enumerate}

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