Quantum TGD should be reducible to the classical spinor geometry of the configuration
space (\blockquote{world of classical worlds} (WCW)). The possibility to express the
components of WCW K\"ahler metric as anti-commutators of WCW gamma matrices becomes a
practical tool if one assumes that WCW gamma matrices correspond to Noether super charges
for super-symplectic algebra of WCW. The possibility to express the K\"ahler metric also
in terms of K\"ahler function identified as K\"ahler for Euclidian space-time regions
leads to a duality analogous to AdS/CFT duality.

Physical states should correspond to the modes of the WCW spinor fields and the
identification of the fermionic oscillator operators as super-symplectic charges is highly attractive.
 WCW spinor fields cannot, as one might naively expect,
be carriers of a definite spin and unit fermion number. Concerning the construction of
the WCW spinor structure there are some important clues.

\vm{\it 1. Geometrization of fermionic statistics in terms of WCW spinor
structure}\vm

The great vision has been that the second quantization of the induced spinor fields can be
understood geometrically in terms of the WCW spinor structure in the sense that the
anti-commutation relations for WCW gamma matrices require anti-commutation relations for
the oscillator operators for free second quantized induced spinor fields.

\begin{enumerate}

\item One must   identify the counterparts of second quantized fermion fields as objects
closely related to the WCW spinor structure.   Ramond model has as its
basic field the anti-commuting field $\Gamma^k(x)$, whose Fourier components are analogous
to the gamma matrices of the WCW and which behaves like a spin $3/2$ fermionic field
rather than a vector field. This suggests that the complexified gamma matrices of the WCW
are analogous to spin $3/2$ fields and therefore expressible in terms of the fermionic
oscillator operators so that their anti-commutativity naturally derives from the
anti-commutativity of the fermionic oscillator operators.

As a consequence, WCW spinor fields can have arbitrary fermion number and there would be hopes of describing the whole physics in terms of WCW spinor field. Clearly, fermionic oscillator operators would act in degrees of freedom analogous to the spin degrees of freedom of the ordinary spinor and bosonic oscillator operators would act in degrees of freedom analogous to the \blockquote{orbital} degrees of freedom of the ordinary spinor field.

\item The classical theory for the bosonic fields is an essential part of the WCW geometry. It would be very nice if the classical theory for the spinor fields would be contained in the definition of the WCW spinor structure somehow. The properties of the modified massless Dirac operator associated with the induced spinor structure are indeed very physical. The modified massless Dirac equation for the induced spinors predicts a separate conservation of baryon and lepton numbers. The differences between quarks and leptons result from the different couplings to the CP_2 K\"ahler potential. In fact, these properties are shared by the solutions of massless Dirac equation of the imbedding space.

\item Since TGD should have a close relationship to the ordinary quantum field theories it would be highly desirable that the second quantized free induced spinor field would somehow appear in the definition of the WCW geometry. This is indeed true if the complexified WCW gamma matrices are linearly related to the oscillator operators associated with the second quantized induced spinor field on the space-time surface and/or its boundaries. There is actually no deep reason forbidding the gamma matrices of the WCW to be spin half odd-integer objects whereas in the finite-dimensional case this is not possible in general. In fact, in the finite-dimensional case the equivalence of the spinorial and vectorial vielbeins forces the spinor and vector representations of the vielbein group $SO(D)$ to have same dimension and this is possible for $D=8$-dimensional Euclidian space only. This coincidence might explain the success of 10-dimensional super

string models for which the physical degrees of freedom effectively
correspond to an
8-dimensional Euclidian space.

\item It took a long time to realize that the ordinary definition of
the gamma matrix
algebra in terms of the anti-commutators $\{\gamma_A,\gamma_B\}
=2g_{AB}$ must in TGD
context be replaced with $\{\gamma_A^{\dagger},\gamma_B\} =iJ_{AB}
\per$, where J_{AB}
denotes the matrix elements of the K\"ahler form of the WCW. The
presence of the Hermitian
conjugation is necessary because WCW gamma matrices carry fermion
number.
This definition is numerically equivalent with the standard one in
the complex
coordinates. The realization of this delicacy is necessary in order
to understand how the
square of the WCW Dirac operator comes out correctly.

\end{enumerate}

\vm{\it 2. K\"ahler-Dirac equation for induced spinor fields}\vm

Super-symmetry between fermionic and and WCW degrees of freedom
dictates that
K\"ahler-Dirac action   is the unique choice for the Dirac action

There are several approaches for solving the K\"ahler-Dirac (or
K\"ahler-Dirac)
equation.

\begin{enumerate}

\item The most promising approach assumes that the solutions are
restricted on 2-D
stringy world sheets and/or partonic 2-surfaces. This strange
looking view is a rather
natural consequence of both strong form of holography and of number
theoretic vision, and
also follows from the notion of finite measurement resolution having
discretization at
partonic 2-surfaces as a geometric correlate. Furthermore, the
conditions stating that
electric charge is well-defined for preferred extremals forces the
localization of the
modes to 2-D surfaces in the generic case. This also resolves the
interpretational
problems related to possibility of strong parity breaking effects
since induce W fields
and possibly also Z^0 field above weak scale, vahish at these
surfaces.

The condition that also spinor dynamics is associative suggests strongly that the localization to 2-D surface occurs always (for right-handed neutrino the above conditions does not apply this). The induced gauge potentials are the possible source of trouble but the holomorphy of spinor modes completely analogous to that encountered in string models saves the situation. Whether holomorphy could be replaced with its quaternionic counterpart in Euclidian regions is not clear (this if W fields vanish at the entire space-time surface so that 4-D modes are possible). Neither it is clear whether the localization to 2-D surfaces occurs also in Euclidian regions with 4-D CP_2 projection.

\item One expects that stringy approach based on 4-D generalization of conformal invariance or its 2-D variant at 2-D preferred surfaces should also allow to understand the K\"ahler-Dirac equation. Conformal invariance indeed allows to write the solutions explicitly using formulas similar to encountered in string models. In accordance with the earlier conjecture, all modes of the K\"ahler-Dirac operator generate badly broken super-symmetries.

\item Well-definedness of em charge is not enough to localize spinor modes at string world sheets. Covariantly constant right-handed neutrino certainly defines solutions de-localized inside entire space-time sheet. This need not be the case if right-handed neutrino is not covarianty constant since the non-vanishing CP_2 part for the induced gamma matrices mixes it with left-handed neutrino. For massless extremals (at least) the CP_2 part however vanishes and right-handed neutrino allows also massless holomorphic modes de-localized at entire space-time surface and the de-localization inside Euclidian region defining the line of generalized Feynman diagram is a good candidate for the right-handed neutrino generating the least broken super-symmetry. This super-symmetry seems however to differ from the ordinary one in that ν_R is expected to behave like a passive spectator in the scattering. Also for the left-handed neutrino solutions localized inside string world sheet the condition that coupling to right-handed neutrino vanishes is guaranteed if gamma matrices are either purely Minkowskian or CP_2 like inside the world sheet.

\end{enumerate}

awcwspin

Quantum TGD should be reducible to the classical spinor geometry of the configuration
space (\blockquote{world of classical worlds} (WCW)). The possibility to express the
components of WCW K\"ahler metric as anti-commutators of WCW gamma matrices becomes a
practical tool if one assumes that WCW gamma matrices correspond to Noether super charges
for super-symplectic algebra of WCW. The possibility to express the K\"ahler metric also
in terms of K\"ahler function identified as K\"ahler for Euclidian space-time regions
leads to a duality analogous to AdS/CFT duality.

Physical states should correspond to the modes of the WCW spinor fields and the
identification of the fermionic oscillator operators as super-symplectic charges is highly attractive.
WCW spinor fields cannot, as one might naively expect,
be carriers of a definite spin and unit fermion number. Concerning the construction of
the WCW spinor structure there are some important clues.

\vm{\it 1. Geometrization of fermionic statistics in terms of WCW spinor
structure}\vm

The great vision has been that the second quantization of the induced spinor fields can be
understood geometrically in terms of the WCW spinor structure in the sense that the
anti-commutation relations for WCW gamma matrices require anti-commutation relations for
the oscillator operators for free second quantized induced spinor fields.

\begin{enumerate}

\item One must identify the counterparts of second quantized fermion fields as objects
closely related to the WCW spinor structure. Ramond model has as its
basic field the anti-commuting field $\Gamma^k(x)$, whose Fourier components are analogous
to the gamma matrices of the WCW and which behaves like a spin $3/2$ fermionic field
rather than a vector field. This suggests that the complexified

gamma matrices of the WCW
are analogous to spin $3/2$ fields and therefore expressible in terms of the fermionic
oscillator operators so that their anti-commutativity naturally derives from the
anti-commutativity of the fermionic oscillator operators.

As a consequence, WCW spinor fields can have arbitrary fermion number and there would be
hopes of describing the whole physics in terms of WCW spinor field. Clearly, fermionic
oscillator operators would act in degrees of freedom analogous to the spin degrees of
freedom of the ordinary spinor and bosonic oscillator operators would act in degrees of
freedom analogous to the \blockquote{orbital} degrees of freedom of the ordinary spinor
field.

\item The classical theory for the bosonic fields is an essential part of the WCW
geometry. It would be very nice if the classical theory for the spinor fields would be
contained in the definition of the WCW spinor structure somehow. The properties of the
modified massless Dirac operator associated with the induced spinor structure are indeed
very physical. The modified massless Dirac equation for the induced spinors predicts a
separate conservation of baryon and lepton numbers. The differences between quarks and
leptons result from the different couplings to the CP_2 K\"ahler potential. In fact,
these properties are shared by the solutions of massless Dirac equation of the imbedding
space.

\item Since TGD should have a close relationship to the ordinary quantum field theories
it would be highly desirable that the second quantized free induced spinor field would
somehow appear in the definition of the WCW geometry. This is indeed true if the
complexified WCW gamma matrices are linearly related to the oscillator operators
associated with the second quantized induced spinor field on the space-time surface and/or
its boundaries. There is actually no deep reason forbidding the gamma matrices of the WCW
to be spin half odd-integer objects whereas in the finite-dimensional case this is not
possible in general. In fact, in the finite-dimensional case the equivalence of the

spinorial and vectorial vielbeins forces the spinor and vector representations of the
vielbein group $SO(D)$ to have same dimension and this is possible for $D=8$-dimensional
Euclidian space only. This coincidence might explain the success of 10-dimensional super
string models for which the physical degrees of freedom effectively correspond to an
8-dimensional Euclidian space.

\item It took a long time to realize that the ordinary definition of the gamma matrix
algebra in terms of the anti-commutators $\{\gamma_A,\gamma_B\} =2g_{AB}$ must in TGD
context be replaced with $\{\gamma_A^{\dagger},\gamma_B\} =iJ_{AB}\per$, where J_{AB}
denotes the matrix elements of the K\"ahler form of the WCW. The presence of the Hermitian
conjugation is necessary because WCW gamma matrices carry fermion number.
This definition is numerically equivalent with the standard one in the complex
coordinates. The realization of this delicacy is necessary in order to understand how the
square of the WCW Dirac operator comes out correctly.

\end{enumerate}

\vm{\it 2. K\"ahler-Dirac equation for induced spinor fields}\vm

Super-symmetry between fermionic and and WCW degrees of freedom dictates that
K\"ahler-Dirac action   is the unique choice for the Dirac action

There are several approaches for solving the K\"ahler-Dirac (or K\"ahler-Dirac)
equation.

\begin{enumerate}

\item The most promising approach assumes that the solutions are restricted on 2-D
stringy world sheets and/or partonic 2-surfaces. This strange looking view is a rather
natural consequence of both strong form of holography and of number theoretic vision, and
also follows from the notion of finite measurement resolution having discretization at
partonic 2-surfaces as a geometric correlate. Furthermore, the conditions stating that
electric charge is well-defined for preferred extremals forces the localization of the
modes to 2-D surfaces in the generic case. This also resolves the interpretational

problems related to possibility of strong parity breaking effects since induce W fields and possibly also Z^0 field above weak scale, vahish at these surfaces.

The condition that also spinor dynamics is associative suggests strongly that the localization to 2-D surface occurs always (for right-handed neutrino the above conditions does not apply this). The induced gauge potentials are the possible source of trouble but the holomorphy of spinor modes completely analogous to that encountered in string models saves the situation. Whether holomorphy could be replaced with its quaternionic counterpart in Euclidian regions is not clear (this if W fields vanish at the entire space-time surface so that 4-D modes are possible). Neither it is clear whether the localization to 2-D surfaces occurs also in Euclidian regions with 4-D CP_2 projection.

\item One expects that stringy approach based on 4-D generalization of conformal invariance or its 2-D variant at 2-D preferred surfaces should also allow to understand the K\"ahler-Dirac equation. Conformal invariance indeed allows to write the solutions explicitly using formulas similar to encountered in string models. In accordance with the earlier conjecture, all modes of the K\"ahler-Dirac operator generate badly broken super-symmetries.

\item Well-definedness of em charge is not enough to localize spinor modes at string world sheets. Covariantly constant right-handed neutrino certainly defines solutions de-localized inside entire space-time sheet. This need not be the case if right-handed neutrino is not covarianty constant since the non-vanishing CP_2 part for the induced gamma matrices mixes it with left-handed neutrino. For massless extremals (at least) the CP_2 part however vanishes and right-handed neutrino allows also massless holomorphic modes de-localized at entire space-time surface and the de-localization inside Euclidian region defining the line of generalized Feynman diagram is a good candidate for the right-handed neutrino generating the least broken super-symmetry. This super-symmetry seems however to differ from the ordinary one in that ν_R is expected to behave like a passive spectator in the scattering. Also for the left-handed neutrino solutions localized inside string world sheet the condition that coupling to right-handed neutrino vanishes is guaranteed if gamma matrices are either purely Minkowskian or CP_2 like inside the world sheet.

\end{enumerate}