SUSY and TGD

1. Standard SUSY.

   (a) Supersymmetry is an extension of the notion of super-symmetry allowing the relate bosons and fermions by super-symmetry transformations. Ordinary notion of symmetry does not allow this.

   (b) $\mathcal{N} = 1$ SUSY which is the simplest form of SUSY. There is only one SUSY generator so that there is single spartner for every ordinary particle.

   (c) The problematic prediction is that the spinors are Majorana spinors. This predicts a loss of separate conservation of baryon and lepton numbers predicted also by GUTs assembling leptons and quarks to same multiplets.

   (d) The problematic aspect of SUSYs is that the supersymmetric variant of Higgs mechanism is not unique and is not very convincing.

   (e) There is a huge variety of $\mathcal{N} = 1$ SUSY symmetric theories. The minimal su- per-symmetric extension of standard model assigns (MSSM) superpartners to standard model particles.

   (f) More complex models start from supergravity and assume mechanism of su- persymmetry breaking.

   (g) Also superstring models predicted SUSY at TeV energies. This was of course only a "prediction" since landscape catastrophe destroys the predictivity of the theory.

2. Standard SUSY and LHC.

   (a) Before LHC the models predicted that SUSY would be observed at LHC. SUSY would have solved the fine tuning problem for Higgs mas and stabilized it since radiative corrections from particles and their spartners to Higgs mass would have cancelled at high energy limit.

   (b) The recent experimental work at LHC has however demonstrated that spart- nersif they exist at all in TeV energy scale, are too heavy to resolve the problem.

3. In TGD framework the fundamental symmetry is super-conformal invariance.

   (a) TGD version of conformal symmetry extends the conformal symmetry from the level of 2-D string world sheets to the level of 3-D light-like boundary δM^4_+ of M^4 light-cone and lightlike partonic orbits, both of which are metrically 2-D.

   (b) The fundamental superconformal algebra is generated by the symplectic algebra assignable to $\delta M^4 \times CP_2$ having natural conformal structure associated with the radial light-like coordinate taking the role of complex coordinate z in super-conformal theories.

   (c) The modes of Kähler Dirac equation have well-define em charge only if the region of space-time carrying them is em neutral in the sense that classical W fields vanish. The condition for em neutrality states that CP_2 projection of this region is 2-D. The region can be 2-D string world sheet with vanishing W fields or it can be 4-D but have 2-D CP_2 projection. The conjecture is that space-time surfaces of this kind exist and for them CP_2 projection belongs to a homologically non-trivial geodesic sphere. It could be also complex submanifold of CP_2.

4. Right handed neutrino and SUSY.

   (a) Right-handed neutrino ν_R has no electroweak couplings and is exceptional. Covariantly constant ν_R can be de-localized into entire 4-D space-time surface. This is true also if the CP_2 part of Kähler-Dirac operator annihilates ν_R.

   (b) Also em neutral space-times allow 4-D modes which however can be expressed as continuous integrals over 2-D modes localized at 2-D em neutral string world sheets.

   (c) Cosmic strings postulated to dominate primordial cosmology would be this kind of space-time surfaces. In transition to radiation dominated cosmology fermion number would be localized to 2-D string world sheets.

(d) There are two kinds of superconformal representations. Covariantly constant ν_R gives rise to a representation of supersymplectic algebra and charged modes give rise to a representation of the isometry algebra. The second representation corresponds to SUSY broken badly by CP_2 geometry.

(e) The badly broken SUSY corresponds to large $\mathcal{N}$ (even infinite $\mathcal{N}$ at ideal measurement resolution allowing infinite number of spinors modes at string world sheets). The slightly broken variant would correspond to the symplectic super-conformal representations. In both cases $\mathcal{N} > 1$ means that baryon and lepton numbers can be conserved separately.

5. Does TGD really predict $\mathcal{N} > 1$ SUSY at low energies?

    (a) It is not quite clear whether the $\mathcal{N} > 1$ SUSY generated by ν_R corresponds to the ordinary SUSY. ν_R does not have e-w interactions and one might argue that its addition to the space-time sheet representing particle does not imply the formation of bound state in which both move in parallel as a single coherent unit with definite spin/helicity.

    (b) If this occurs then one can expect that the vertices obey SUSY reflecting itself in the helicity dependence of of scattering amplitudes. An attractive assumption is that all string ends at partonic 2-surface have parallel light-like momenta parallel to that of ν_R.