During years the basic mathematical and conceptual building bricks of quantum TGD have become rather obvious. The basic goal is the construction of scattering amplitudes.

\begin{enumerate}

\item Zero Energy Ontology (ZEO) forces to generalize the notion of S-matrix by introducing M-matrix as a matrix characterizing the entanglement between pairs of states forming zero energy states.

\item Second building brick consists of various hierarchies and connections between them. There is the hierarchy of quantum criticalities for super-symplectic algebra and its Yangian extension acting as a spectrum generating algebra. This hierarchy is closely related to the hierarchy of Planck constants $h_{eff}=n\times h$. The hierarchies of criticalities correspond also to fractal hierarchies of breakings of super-symplectic gauge conformal symmetry: only the sub-algebra isomorphic to the original gauge algebra acts as gauge algebra after the breaking. At each step one criticality is reduced and the number of physical degrees of freedom increases.

There is a natural connection between these hierarchies with the hierarchies of hyperfinite factors of type II$_1$ (HFFs) and their inclusions providing a description for the notion of measurement resolution.

\item Number theoretic realized as adelic physics fusing real number based physics as a correlate of sensory experience and p-adic physics as correlate of cognition involves several elements: M^8-H duality, hierarchy of effective Planck constants $h_{eff}= nh_0$ with n identified as a dimension of extension of rationals, cognitive representations characterized by extensions of rationals, and p-adic length scale hypothesis.

\end{enumerate}

The identification of the TGD counterpart of S-matrix is the key topic of this chapter. What this matrix actually means is far from obvious.

\begin{enumerate}

\item One can characterize zero energy state by a "square root" of density matrix which is product of hermitian matrix and unitary matrix: I have called this matrix M-matrix. The unitary matrix related to the M-matrix could relate closely to the S-matrix assigned with particle reactions.

\item One can assign the analog of unitary S-matrix to "small"

state function reductions (SSFRs) defining the TGD counterparts of "weak" measurements. The states at the passive boundary PB are unaffected, which has interpretation as the TGD counterpart of Zeno effect. This S-matrix could relate to the evolution of self as a conscious entity and to its cognitive time evolution.

\item One can also assign an S-matrix like entity to "big" SFRs (BSFRs) in which the arrow of time changes. This S-matrix would be the counterpart of the ordinary S-matrix and should closely relate to the M-matrix.

\item I have also introduced the notion of U-matrix, which would be defined between zero energy states without fixing states at the passive boundary essential for fixing the arrow of time. This notion has remained somewhat misty and it seems that it is not needed since the matrices assigned SSFRs and BSFRs indeed are between zero energy states.

\end{enumerate}

The construction of these matrices is discussed at the general level.