

# p-Adic length Scale Hypothesis

The book is devoted to the applications of p-adic length scale hypothesis.

1. p-Adic length scale hypothesis states that primes  $p \simeq 2^k$ ,  $k$  integer, in particular prime, define preferred p-adic length scales. Physical arguments supporting this hypothesis are based on the generalization of Hawking's area law for blackhole entropy so that it applies in case of elementary particles. A deeper number theory based justification for this hypothesis is based on the generalization of the number concept fusing real number fields and p-adic number fields among common rationals or numbers in their non-trivial algebraic extensions. This approach also justifies the notion of multi-p-fractality and allows to understand scaling law in terms of simultaneous  $p \simeq 2^k$ - and 2-fractality.
2. In TGD framework the levels of dark matter hierarchy are labeled by the values of dynamical quantized Planck constant. The justification for the hypothesis provided by quantum classical correspondence and the fact the sizes of space-time sheets identifiable as quantum coherence regions can be arbitrarily large.
3. The weak form of electric-magnetic duality is the newest building brick of the vision and leads to a detailed view about electro-weak screening and color confinement and predicts new physics below weak scales. The weak form of electric-magnetic duality allows to identify Higgs bosons and to understand how they provide the longitudinal polarizations of gauge bosons. The most natural option is that photon eats the remaining Higgs scalar and receives a small mass. This true for all bosons regarded as massless and allows to have exact Yangian symmetry requiring the vanishing of IR divergences. Higgs potential and vacuum expectation of Higgs are not needed in the model.
4. Twistors emerge naturally in TGD framework and several proposal for twistorialization of TGD is discussed in two chapters devoted to the topic. Twistorial approach combined with zero energy ontology, bosonic emergence, and the properties of the Chern-Simons Dirac operator leads to the conjecture that all particles -also string like objects- can be regarded as bound states of massless particles identifiable as wormhole throats. Also virtual particles would consist of massless wormhole throats but bound state property is not assumed anymore and the energies of wormhole throats can have opposite signs so that space-like momentum exchanges become possible. This implies extremely strong constraints on loop momenta and manifest finiteness of loop integrals.

The first part of the book is about the description of elementary particle massivation in terms of p-adic thermodynamics and Higgs contribution affecting the vacuum conformal weight. In the first chapter the view about quantum TGD from particle physics perspective is discussed and the remaining four chapters are devoted to the detailed calculation of masses of elementary particles and hadrons. In the second part of the book new physics suggested or predicted by TGD is discussed.