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Deep Inelastic Gedanken Scattering off Black Holes

Risto Raitio [1]
02230 Espoo, Finland

Abstract

We develop a model of quark and lepton subconstituents which extends the Standard Model to the Planck scale. The idea is to perform a Gedanken experiment by scattering a probe deep inside a mini black hole. We assume the result is that the core of the hole is a spin 0 or $\frac{1}{2}$ constituent field, grayon. The grayon replaces the singularity of the hole. Three grayons create each a spatial dimension in Minkowski space. A horizon around certain combination of three grayons forms the quarks and leptons. The model would seem to open a door to finite Quantum Gravity consistent with the Standard Model Quantum Theory.

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[1] E-mail: risto@rxo.fi

1 Introduction and Summary

A model for the first generation quark and lepton subconstituents was suggested in [1]. Each quark and lepton was supposed to consist of three mini black hole preons bound together by a confining subcolor interaction.

In this note we correct a mistake in the weak sector structure of the model and make a proposal to develop the raw model one step further. We make a Gedanken experiment of what might happen when exploring a mini black hole deep inside with a probe.

We make the assumption (i) that when probed with a very high energy $E \gg E_{Planck}$ point particle the black hole radiates off its energy and becomes undressed as a fermion or scalar core field: $\psi(0)^m_{k,x}$ (m for charge and color, see Section 2) and $\phi(0)_{k,x}$ with k,x denoting the four momentum and coordinate that the operators create. The core particle has a light mass, something like the Higgs or proton mass (or even zero).

Having come this far it would seem tempting to assume (ii) that the black hole singularity is replaced by the mentioned point core.

Light quark and lepton bound states are formed of three core fermion fields as in [1]. For the subcolor interaction we assume a different process (iii) a geometrical confinement mechanism that could qualitatively described as follows. Three nearby core fermions dress themselves instantaneously due to graviton interactions as stable bound states. An event horizon of radius of the order of l_{Planck} is formed where the core particles are confined. The core fields each create a spatial dimension of Minkowski space. The core fields are called grayons. Higher dimensional universes are possible but are beyond the scope of this short note.

Scalar bound states may be formed in a similar fashion of three scalar grayons. These scalars as well as other kinds of horizon-core formations may contribute to the second and third generation.

In addition to the above three grayon configurations different kind of horizon dressed objects of dimension 1-3 with masses of the order of M_{Planck} are expected to appear. These decay into particles by Hawking radiation.

This short notes presents the basic idea and a list of tasks to carry out, including developing the calculational methods in the first place. As the main point we suggest that there need not be any inconsistency between Quantum Theory and General Relativity.

2 Quarks and Leptons

In the notation of [1] the quark and lepton constituents are fractionally charged subcolor triplet maxon m_i^+ with charge $+\frac{1}{3}$ and i for subcolor, and a neutral subcolor singlet maxon m^0. In fact, the subcolor is not gauge but permutation symmetry.

The first generation quark and lepton bound states are

$$u_k = \epsilon_{ijk} m_i^+ m_j^+ m^0 \quad (1)$$
$$d_k = m_k^- m^0 m^0 \quad (2)$$

$$e^- = \epsilon_{ijk} m_i^- m_j^- m_k^- \quad (3)$$
$$\nu_e = m^0 m^0 m^0 \quad (4)$$

Where permutations are not indicated these states are energetically favored due to the geometrical confinement.

Weak interactions are treated, unlike in [1], traditionally as the broken symmetry gauge theory with an elementary Higgs field.

The other two generations of quarks and leptons are assumed to be due to gravitational interactions or other than three grayon states but no detailed mechanism is known. Higgs couplings to fermions are secondary if at all needed.

3 Some Current Theories

As supported by present experiments the Standard Model (SM) holds well, and perhaps up to near the Planck scale. The present model goes Beyond SM (BSM) to the Planck scale.

Other theories than the SM exist since other gauge groups and subcolors are possible (called scenery) at the Big Bang leading to universes of different types and dimensions.

Grand Unified Theory (GUT) principle works at or below Planck scale, gravity appears to be grayon quantum fields in Minkowski space ultimately.

It is tempting to consider supersymmetry (SUSY) between the spin 0 and $\frac{1}{2}$ grayons.

Structures of this model and String Theory are different. On the other hand, one, two and higher dimensional objects as well as universes of various dimensions may exist in the former.

4 Cosmology

In the present scheme the usual Big Bang initial singularity is smoothed into a very high but finite density banging object. Particles are formed directly from three grayons and indirectly from decaying black objects. This should not lead to major deviations from the standard cosmological model but quantitative differences should be looked for.

An interesting question is the formation of stellar size black holes from matter having grayon constituents.

5 Experimental tests

Deep inelastic scattering off a black hole is not, of course, within reach of any accelerator on earth. Details of cosmological evolution and some very high energy astrophysical processes might be of help.

6 Connection to earlier work

This model can be considered as a variation of earlier work of Einstein, Infeld and Hoffmann [2] who studied the case that elementary particles are singularities of spacetime.

7 Conclusions

The present note contains some ideas how to go beyond the standard model with a model of Planck scale gravity included. It seems that gravity at the Planck scale is as if asymptotically free. It may be possible to solve the hierarchy problem and have a preliminary view of quantum gravity when a mathematical machinery is developed.

References

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