

# Scale invariant unification of forces, fields and particles in a Quantum Vacuum plasma

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**Abstract:** From Bekenstein-Hawking, Susskind and 't Hooft development of the holographic principle, we consider a statistical entropy and thermodynamics approach of a surface-to-volume generalized holographic ratio  $\Phi$  defined in previous work. Applying this analysis, we chart a first order approximation of a scaling coefficient utilizing a face-centered cubic crystalline structure representation of spacetime. The resulting scaling from the Planck scale to the universal scale finds a surprisingly periodic fit to organize matter in the universe. As a result, we can compute exact values defining the fundamental scaling factors of physical interactions. By applying them to radii and masses at the hadronic, electronic and Hubble Constant  $H_0$  scale we find results consistent with current measurements.

Utilizing these scaling factors, we compute a value for the gravitational constant  $G$  with an accuracy of ten significant figures  $10^{-10}$ , representing a first analytical solution for  $G$ , which is typically only known to five significant figures of accuracy from experiment. The accuracy of the value can be confirmed by computing the Rydberg constant, known from measurements to  $10^{-12}$  accuracy, utilizing our scaling factor and our derived value of  $G$ . As a result, we are now able to derive all Planck units to  $10^{-10}$  significant figures.

The relationship between the constants through our computed scaling factors derived from the fundamental holographic ratio  $\Phi$  is further confirmed by the precise computation of the mass of the electron, the radius of the electron, the Bohr magneton and the mass of the proton, all known to  $10^{-10}$  by measurements. As a result, we can demonstrate a clear relationship between the classical scale of the gravitational constant and the quantum energy spectra of the atomic scale from first principle of theoretical tenets alone.

As a result of our scaling law, we now have a geometric interpretation of the fine structure constant  $\alpha$  and the proton to the electron mass ratio  $\mu$  and find the Koide formula to be in a direct relationship to the scaling factor. Therefore, utilizing this formula we compute an exact solution for  $\alpha$  and  $\mu$ . We then validate this value to  $10^{-13}$  accuracy by predicting the electron g-factor  $g_e$ . As a result, we are as well able to predict the vacuum permittivity constant  $\epsilon_0$  as an exact value which is known to  $10^{-10}$  accuracy.

Furthermore, considering the 2019 redefinition of the SI base units and the natural Planck units we are now able to unify all the measurements into one analytical framework. Thus, by having only one measurement, such as the Rydberg constant, one can compute all the other values to  $10^{-12}$  accuracy.

This opens the way to the unification of forces, which we scale and find a direct correlation between the forces coupling constants and our holographic ratio  $\Phi$  at all scales. Resulting in the unification of particles, fundamental constants and forces in a unified theoretical framework based on a fractalization of spacetime defined by an entropic principle related to the surface-to-volume holographic ratio  $\Phi$ .

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