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The meaning of mass

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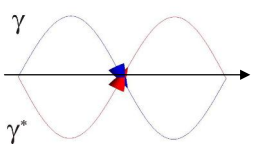
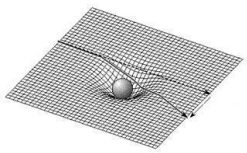
Nowadays we hunt for Higgs boson to give masses for all particles, but apparently not quite knowing what mass means. We do know though that the mass-energy relation $E = mc^2$ places the body with mass m relative to the free space whose permittivity ε_0 and permeability μ_0 combine in the squared speed of light $c^2 = 1/\varepsilon_0\mu_0$. We do know also that $c^2 = GM/2R$ relates to the total mass of the Universe M within its huge radius R. In view of that, the photon-embodied vacuum, in balance with everything else, is the natural reference to define masses of all bodies and particles.

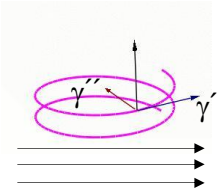
Despite this natural notion we tend to reason that energy density in radiation falls short by orders of magnitude to account for gravitational effects. We are also eager to abandon anew the old idea of luminiferous aether simply because we do not see light when a body falls down in a gravitational field. Yet, when we reverse the change of state by returning the body back up on its initial height, we will ultimately consume photons from insolation that produced our food to do the work. Since no change of state will yield less than one quantum of action, the logic entails that everything is ultimately composed of photons in some number of integers.



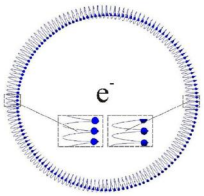
To imagine the photon-embodied vacuum without light is not hard from photons in propagation along all directions but on the average in pairs of opposite polarizations to give rise to vector potential without phase gradient, that is, without electromagnetic field. These compound bosons traverse the Universe over along their least-time paths. Conversely, the photons that are still bound on their curved geodesics make the particles.



A curved path can be compared with straight reference lines in terms of a projection, to see how far the bound local path is from being a free universal path. According to the theorem of Gauss and Bonnet, the geodesic curvature $k_g = \mathrm{n} \cdot (\gamma' \times \gamma'')/|\gamma'|^3$ sums up along the path x to a characteristic quantity $\chi(M) = ||\int k_g dx||$, that is proportional to the mass.



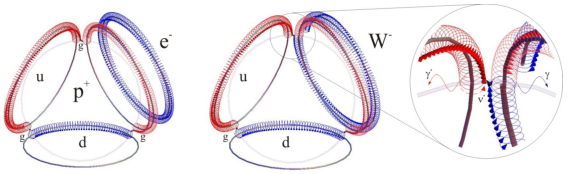
Since the average energy density of contemporary cosmos is low, also on the average, that is, the common elementary particles must be actions whose paths will project only little on the universal surroundings. A torus is an example of a path whose projection is tiny because the loops at the opposite sides cancel each other almost perfectly. Therefore the mass of a toroid action is small. This closed chiral circulation of energy density generates a charge and magnetic moment, so it takes only a little imagination to associate the torus with the electron.



According to Gauss' law the density of the field sumps up to a constant $2K = \int \rho \mathrm{v} \cdot \mathrm{E} dt = \int \rho \mathrm{E} \cdot d\mathrm{x} = e^2/4\pi\varepsilon x$ so that the stationary action can be compared relative to the most elemental bound action $\hbar$, the neutrino, by a dimensionless coupling constant, the fine-structure constant $\alpha = L/\hbar = \int 2K dt/\hbar = e^2 Z/2h$ when denoting the vacuum impedance $Z^2 = \mu/\varepsilon = (c\varepsilon)^{-2}$. Its inverse $1/\alpha \cong (137^2 + \pi^2)^{1/2} = 137.036$ implies to us that the electron torus comprises 138 quanta in 137 loops. The number of quanta must exceed at least by one the number of windings for the rising, modular path to close exactly.

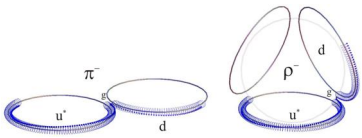
Since the charges of quarks carry integer fractions of the unit charge, the proton can be constructed as a closed circulation where two up-quarks, each comprising a $^2/_3$-fraction of e^+, and one down-quark, as a $^1/_3$-fraction of e^-, are glued together by three high-frequency photons in a tetrahedral coordination. Similarly, the neutron is made of one up-quark and two down-quarks. Since the full 2π-torus contains 138 quanta, the up-quark, that spans the $^2/_3$-arc of torus, contains 92 quanta and the down-quark, that spans the $^1/_3$-arc of torus, comprises

46 quanta. In view of that, matter is not in excess over antimatter but matter is merely the dominating chirality consensus of bound quanta. Based on the electron mass, charge and magnetic moment the corresponding values can be calculated from these geodesics for proton and neutron in accord with those measured.



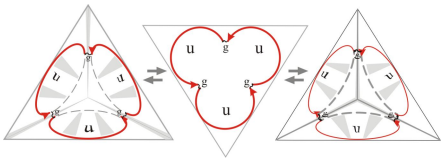
When elementary particles are described as quantized actions, their reactions can be illustrated just as we picture chemical reactions by atomic models. For example, the electron capture will begin when the electron comes close to a proton p^+, where one of its quantum loops will annihilate with antineutrino ν_e^*. The resulting reactive W^- boson will continue to annihilate with up-quark of p^+, and the remaining $^1/_3$ of W^- will close with ν_e as the down-quark of neutron n. The little gap in W^- that was cut in the torus, when the electron reacted with antineutrino, projects a huge mass. In other words, only high-frequency photons of surroundings will resonate in balance with this tiny cavity.

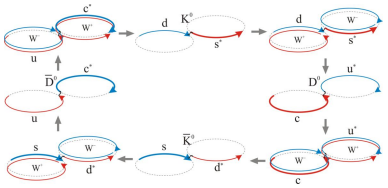
The basic theme of quantized arcs of quarks serves us to construct other particles such as pseudoscalar and vector mesons, exemplified here for pion and rho whose projections provide us with estimates of their mass in agreement with measured values.



Much of the plethora of particles above the ground-state actions are found first under high-energy circumstances such as those fabricated by particle accelerators and those presumably prevailing in stars or other powerful celestial mechanisms that can break free strongly bound photons. Since the 2nd and 3rd generation particles share the 1st generation's basic character, we reason that higher masses of the excited strings reflect some additional curvature about the ground-state ring, toroidal and tetrahedral topologies.

Likewise, we regard resonant states as topological fluctuations and oscillations as repetitive transitions from one action to another. Di-mesons and tetra-quarks are expected to comply with the basic geometry which also implies how baryons could pack tight together, e.g., in an atomic nucleus.





The representation of particles as least-action paths may seem at first as an uprising idea, but the atomism, e.g., in the form of luxon theory is nothing new. Also, the torus model of electron appeared early on and closed string models have maintained interest ever since.

Some two hundred years ago the atomic composition of chemical substances was just an oracular idea among scholars but today atomic models of compounds are familiar to pupils. In the same way, the photon is the atom, i.e. the unbreakable action which is the basic building block of everything that exists. Indeed the discrete character of nature is reflected in multiplicity at all levels of its hierarchical organization giving rise to scaling laws.

The all-around hovering universal energy density in a form of the photon-embodied physical vacuum that couples everything to everything else realizes Mach's thinking about inertia. The present-day surroundings of a sparse density force bodies to move toward each other as we see from the galaxies close by whereas the past surroundings of the energy intense nascent Universe forced bodies apart as we see from the galaxies faraway. Moreover, no body will propagate without perturbing its surrounding vacuum as is familiar from the double-slit experiment.

When everything is described in terms of actions, then everything is in an innate relation to everything else. The curvature and chirality of paths invariably relate gravitational and electromagnetic interactions as well as weak and strong interactions with one another. In this sense no fundamental force is more fundamental than any other, but all forces, as Gauss said, relate to curvatures. The ratio of radii is the ratio of forces, may it be that of the Universe, electron or neutrino. According to the natural principle all forces as energy differences of all kinds are leveling off in the least time.

In short, nowadays we hunt for Higgs and we hunt for WIMPs as well as for dark energy, but really we hunt only for our delusions since we should look for the photons we sense but cannot see.