

## Some applications of a preon model

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Some applications of a preon model, presented in previous articles, are proposed. The model derives from the concept of bifurcation from theory of nonlinear dynamical systems applied to particle physics, and predicts the existence of mass quanta linked together by a recursive and scale-invariant relation. It also makes use of the concepts of fractional spin, superluminality and variable dimensions of spacetime.

In previous articles a preon model had been proposed, in a mainly qualitative and naive way [1]. Briefly, the existence of two preonic particles, the mark and the supermark, had been hypothesized, whose masses can be derived recursively from the mass of the electron according to the following relations.

$$m_{\text{mark}} = m_e/4\alpha = 17.5 \text{ MeV}$$

$$m_{\text{supermark}} = m_{\text{mark}}/4\alpha = m_e/(4\alpha)^2 = 599.75 \text{ MeV}$$

where  $m_e$  is the mass of the electron 0.511 keV and  $\alpha$  is the fine structure constant  $(137.036)^{-1}$ .

The model also uses the concept of recursion with respect to spin (the mark spin is supposed to be 1/4, and for the supermark spin is 1/8) and with respect to the spacetime dimensions in which the preon's behavior can be described (8D for the mark, 16D for the supermark).

The model also admits for the possibility of superluminal behavior for particles [2].

The mass quantization model has been used to provide an explanation for numerical regularities present in the masses of particles [3], and also for the X17 particle [4].

In this article, the applicability of the model to two phenomena is proposed.

### The decay of the neutral pion

In our model, particle production is a dynamical process. As a photon can “produce” an electron-positron pair, an electron (or a positron) can “produce” a pair of marks.

Neutral pion has a mass of 134.97 MeV. This mass roughly justifies the hypothesis of the neutral pion as composed by eight marks.

In [5, p. 3] are listed the known decays of the neutral pion. All the observed decays present a combination of photons and electrons-positrons which agrees with the eight-marks hypothesis.

I.e., the decay of eight marks produces either two photons, either an electron-positron pair plus a photon, or four electrons-positrons.

But there is a problem with a decay in only an electron-positron pair, with branching ratio  $(6.46 \pm 0.33) \times 10^{-8}$ .

A possible explanation of this rare decay, remaining in the framework of the mark model, is the production of a superluminal electron-positron pair [6].

### Intrinsic charm

One feature of the mark model is a vectorial representation of mass. At the electron-4D level, mass

is a scalar, but at the mark-8D level mass can be represented by a complex number, and at the supermark-16D level mass is a quaternion. Anyway, we argue that a 4D observer is capable of detect only the projection of the mass vector onto the real axis.

This point of view was proposed in [4] as a possible explanation of the origin of X17 as composed by four marks, three of which are in a “dark” state, i.e. with a minimal mass vector projection on the real axis, and only one mark in a “visible” state, with the projection on the real axis coincident (or almost coincident) with the modulus of the mass vector. The nearness of the X17 mass with the mark mass is a consequence of this assumption.

Charm quark has a mass of 1.27 GeV, which is compatible with a mass of two supermarks. Assuming the point of view of the mark model, this gives us the information that charm is composed *at least* by two supermarks.

Now let us apply the above hypothetical mechanism to the recent claim about the evidence of intrinsic charm quarks in the proton [7].

A divulgative article in Quanta Magazine [8] presents a picture labeled “The proton sometimes acts like a ‘molecule’ of five quarks”, where an oscillating behavior is presented in which a charm quark-antiquark pair appears and disappears.

Oversimplifying, we see a possible explanation for this behavior as a process of production of pairs of supermarks from some of the marks contained in the proton, with a subsequent annihilation of the supermark pair and a return to the mark level.

The process then repeats itself, producing the oscillations depicted in [8].

### **Beyond ordinary statistics**

The mark model has its roots in nonlinear dynamical systems theory. Recently there have been other proposals relating to the application of the theory of nonlinear systems to particle physics.

Let us cite [9]:

“At the same time that Hagedorn was developing his SCT (Self-Consistent Thermodynamic) theory, Mandelbrot was proposing the existence of systems with fractionary dimensions, the fractals [...]. Fractals are systems that present some special characteristics as scaling symmetry and self-similarity. Today the fractal structure is known to be present in many complex systems [..., ...]. It is interesting to note that Tsallis motivation to propose his generalized entropy was fractal systems [...].”

In thermofractal theory, the good agreement of the deduced Tsallis entropic index,  $q$ , with the value obtained experimentally [10], could be related in our opinion to the mark model, which has its origin in the bifurcation phenomenon of nonlinear systems, which leads to a self-similar recursion typical of fractal systems.

### **Recursive production of vortex-antivortex pairs**

The topological object identified as a model for producing marks is the Falaco soliton (half of a vortex ring) [11]. This seems appropriate because the Navier-Stokes equations are nonlinear, and bifurcation phenomena are common in fluid dynamics [12].

Let us cite [13]: “I propose (not yet supported by the mathematics) that the energy density and ‘torsion’ of space in this interaction can result in stable vortex pairs that are connected in the manner of Falaco solitons (Fig. 5). However, being vortices of a 3-D surface in 4-space, the

connection is in time, not in space. It is a wormhole.”

The mechanism underlying the mark model, we repeat ourselves, is through a bifurcation of a vortex that produces a vortex-antivortex pair. We hypothesize that the recursive repetition of the process is made possible by the nonlinear dynamics of fluids. The recursiveness of the process follows from the structure of the bifurcation tree.

As for the nature of the fluid in which these bifurcations are hypothesized to occur, there are various proposals in the literature, including Superfluid Vacuum Theory and Superfluid Quantum Space-Time [14].

This mechanism also seems to appear in doubling of spinors. As is stated in [15], there has been historically the development: 2-spinors (Pauli)  $\rightarrow$  4-spinors (Dirac)  $\rightarrow$  8-spinors (Mie). 16-spinors have also been used in literature [16].

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