The electromagnetic origin of the 3 GeV peak in the flux profiles of Cosmic Rays protons.

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Abstract:

In two recent publications we developed a field theoretical model in which the origin of baryons is associated with the stabilization of charge vortices from vacuum. According to this model the vortices should condense from a state 2.7 GeV higher in energy than the proton rest energy. In support of such a picture, all number- and energy-flux profiles taken from protons cosmic rays (CR) display a peak at about 2.5- 4 GeV(although the form of this peak may suffer the influence on particles of the Sun magnetic field). In the present work we demonstrate through a simple calculation that the observed 3 GeV would correspond to the electromagnetic external force necessary to break the "elastic" limits of a vortex provided by internal electric forces. Any excess energy should be released through radiation to avoid collapse of the vortices, so that particles energies mostly concentrate at values lower than 3 GeV.

Introduction.

In recent years we have worked extensively on heuristic models for baryons, which resulted in three publications [1-3]. In the two most recent publications[1,2] we developed a fieldtheoretical model which supplemented the essentially phenomenological treatment initially presented [3]. The model in [3] actually extends similar work of Barut[4] and Post[5] on the subject, reobtaining Barut's main final results which relate mass of baryons to the inverse of the alpha-constant [4]. In particular, Barut's *n* (a number of action quanta from the Bohr-Sommerfeld conditions) reappears in our treatment as a number of magnetic flux-quanta [1-3].

Perhaps the main original result of this work has been the deduction that baryons should be the result of a process of stabilization of vortices of charge, generated from a parent state located at 3.7 GeV[1]. Such state might be associated with the EM vacuum and the baryons would come as a result of stabilized excitations of EM origin acting upon that vacuum. Support for such an explanation comes from the energy distribution of protons and other particles in cosmic rays (CR)[6], which peak in the range 2.5-4 GeV. The purpose of the present paper is to supplement the brief analysis of this experimental observation advanced in [2]. As we show below the association of the peak position with the limiting "elastic" strength of a vortex of charge is rather straightforward, as well as the demonstration that the internal cohesion forces most probably have electric origin.

Electric forces in stretched charge vortices.

A residual magnetic field permeates interstellar space[6]. In view of the gigantic speeds of particles in cosmic rays , such particles are thus subject to accelerated motion through magnetic forces. Let´s concentrate on the case of protons, which represent by far the majority of the contents of CR. Protons are composed of entangled constituents of different charge values, and probably different topological properties associated with these charge values[5]. Positively charged constituents will attempt to displace in the opposite direction of the negatively charged constituents under magnetic forces, which will subject the proton (and for that matter, all other baryons and mesons as well) structure to huge internal stresses to avoid breakdown. We now argue that the observed peak at 3Gev energy directly probes the proton structure elastic response to such stretching magnetic forces.

It is well known that a spring-mass system of mass *m* and elastic spring constant *k* will spontaneously oscillate at its fundamental frequency $\omega = (k/m)^{1/2}$ when subject to a constant force *F* along the spring- mass direction. Let´s assume that the peak energy of 3 GeV corresponds to the ground state energy of the quantum oscillator, so that $\hbar\omega \approx 3$ GeV. With *m* the proton mass, one might imediatelly estimate the elastic constant *k* and natural frequency of this vortex structure, $\hbar\omega = \hbar\,(k/m)^{1/2} = 3$ GeV= $4.8\text{x}\,10^{-10}$ J. We obtain the natural frequency $\omega = 4.6\text{x}10^{24}$ rad/s.

If the forces producing the elastic restoration response of the proton structure to such stresses are electric, which range of inter-charge distortions *x* of the spacing between constituents should be produced at equilibrium?

Upon reaching dynamic equilibrium the average forces are related through (*q* is the proton charge)

$$F\text{ (elastic)} = F\text{(electrostatic)} \qquad (1)$$

$$m\omega^2 x = \frac{q^2}{4\pi\epsilon_0 x^2} \qquad (2)$$

One obtains the distortion $x = 2.4\text{x}10^{-17}$ m = 0.024 fm. We analyze this result below.

Analysis and Conclusions.

As argued in ref. [2], protons vortices of energy around 3 GeV reach their stability limits by losing the energy advantage in comparison to the parent state at 3.7 GeV. One might say that the proton would “melt” into its parent phase.

In the previous paragraph we have translated such rather abstract statement into a form that might be analyzed for instance through the

Lindemann criterion (LC) for melting. According to the LC a solid loses cohesion towards a disordered ("molten") phase when atomic oscillations reach about 5 to 10% of the interatomic distance. The size of a proton is about 0.6 to 0.9 fm, and the term "interatomic" should be replaced by inter-constituent spacing. Such spacing cannot be greater than the size of the particle itself. It is possible to conclude then that the amplitude x = 0.024 fm is about 3 to 4 % of the experimental inter-constituent spacing, and about 5% of the calculated [1] vortex size of 0.46 fm. The Lindemann criterion is therefore being reached at such high kinetic energies.

On the verge of breaking out, protons profusely radiate electromagnetic energy so that the equilibrium given by eq (1) is regained. The result is the observed concentration of protons up to and below 3 GeV energies. Such threshold can be regarded as a fingerprint of the importance of electric forces in the inner constitution of complex particles like the proton.

The same explanation might be attempted to the electron case, in which inner topological features [5] might play the role of the baryon constituents in the analysis.

References

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