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NEW FEATURE FOR AN OLD LARGE NUMBER

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We present a new context for the appearance of the Eddington number (10^{39}), which is due to the examination of elastic scattering of scalar particles ($\pi k \to \pi k$) non--minimally coupled to gravity.

Key-words: Strong interaction; Non-minimal coupling with gravitation; Eddington's number.

It has elapsed already half of century since the first recognition by physicists that one can construct very large adimensional numbers by taking the ratio of constants which belong to the domain of the physical world — and that coincidently all these great numbers seems related to some power of the Eddington number 10^{39}.

We must recognize however, that since Dirac[1]'s tentative program of elucidation of the origin of these coincidences, passing through the modification suggested by Dicke[2] (the so called anthropic principle) in the sixties, there has been little real progress in the comprehension of this question. One still has difficulties even to provide sound arguments which can support the idea that there is indeed a real problem hidden on those apparently innocent coincidences.

Independently of this, it is at least a strange curiosity, which we intend to report here that such number (10^{39}) appeared recently in our work, in a context which seems to be distinct from all others appearances known up to now. It started with an analysis made some years ago of the effect of the mechanism of spontaneous break of symmetry (SSB) on gravity. In a recent paper[3] one uf us has shown that Nature must be cautious in order to avoid the creation of scalar particles with mass $\mu \sim 10^{-33}$eV, since if one such particle exists then it could jump into its fundamental state, with SSB, and then generate a tension in the underlying space-time such that massless particles (neutrino, photon) or very energetic massive particles could create repulsive gravity. There seems to occur a similar phenomenon in supergravity.

However, in order to the scalar particle be effectively in the minimum for the self-interacting potential $V(\phi) = -\mu^2\phi^2 + \sigma\phi^4$, then σ and μ must be related to the bare cosmological constant Λ by the formula $\mu^4 = 8\Lambda\sigma$.

Once this is a very peculiar and singular condition one need not be afraid of having antigravity throughout our world.

We were then induced to analyse less restrictive conditions - and we turned our attention to the coupling of two scalar fields. In order to rest on a value provided by phenomenology we went into the analysis of elastic strong interaction of scalar particles (e.g., $\pi k \to \pi k$). In a non--trivial riemannian ST a quasi-conformal dynamics is described by the Lagrangian

$$\mathcal{L} = \sqrt{-g}\left\{\partial_\mu\phi^*\partial_\nu\phi\, g^{\mu\nu} - \mu^2\phi^2 + \partial_\mu\psi^*\partial_\nu\psi\, g^{\mu\nu} - M^2\psi^2 + \beta\,\psi^2\phi^2 + \right.$$
$$\left. + \frac{1}{k}R - \frac{1}{6}R\,(\phi^2 + \psi^2)\right\} + \mathcal{L}_{rest}$$

Remark that we do not restrict from the begining the strength β of the strong interaction between ϕ and ψ to its present value $g_s^2 \sim 15\ \hbar c$, once we would also like to know if there is any net back-effect from gravity upon strong forces.

The system $(\phi, \psi, g_{\mu\nu})$ admits a fundamental state $(\phi_o, \psi_o, g_{\mu\nu})$ in which the consequence of having constant values ϕ_o and ψ_o for the scalar fields is to induce both an effective cosmological constant and the renormalization of the gravity constant k.

By the analysis of such state, we are led to impose a natural bound for the minimum possible value for β, if we still require gravity to be always attractive. It is a remarkable fact that this basic property of gravity implies a restriction on the strength of strong forces.

The next question one has to face is just this: what is the relation between the minimum value permissible of β and the actual value chosen by Nature g_s ?

Taking into account that $\mu_\pi \sim \mu_k$, we obtain that

$$\frac{\beta_{min}}{g_s} \sim 10^{-39} \quad .$$

One should not be surprised by the fact that Nature carefully has chosen a real great value, very far from the minimum value allowed. However it seems indeed intriguing that this value is precisely the ancient famous Eddington number !

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