Imprints of Discrete Space Time - A Brief Note

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Abstract

We point out that the observed decay mode of the pion and the Kaon decay puzzle are really imprints of discrete micro space-time.

In recent years ideas of discrete space time have been revived through the work of several scholars and by the author within the context of Kerr-Newman Black Hole type formulation of the electron[1]-[5]. Further, even more recently this has been considered in the context of a stochastic underpinning[6, 7]. Let us now consider two of the imprints that such discrete space time would have.

First we consider the case of the neutral pion. Within the framework of the Kerr-Newman metric type formulation referred to above, it is possible to recover the usual picture of a pion as a quark-anti quark bound state [8, 9], though equally well we could think of it as an electron-positron bound state also[4, 10]. In this case we have,

$$\frac{mv^2}{r} = \frac{e^2}{r^2} \tag{1}$$

Consistently with the above formulation, if we take $v = c$ from (1) we get the correct Compton wavelength $l_\pi = r$ of the pion.

However this appears to go against the fact that there would be pair annihilation with the release of two photons. However if we consider discrete space time, the situation would be different. In this case the Schrodinger equation

$$H\psi = E\psi \tag{2}$$

where H contains the above Coulumb interaction could be written, in terms of the space and time separated wave function components as (Cf. also ref.[2]),

$$H\psi = E\phi T = \phi\imath\hbar[\frac{T(t-\tau)-T}{\tau}] \tag{3}$$

where τ is the minimum time cut off which in the above work has been taken to be the Compton time (Cf.refs.[4] and [5]). If, as usual we let $T = exp(irt)$ we get

$$E = -\frac{2\hbar}{\tau} sin\frac{\tau r}{2} \tag{4}$$

(4) shows that if,

$$|E| < \frac{2\hbar}{\tau} \tag{5}$$

holds then there are stable bound states. Indeed inequality (5) holds good when τ is the Compton time and E is the total energy mc^2. Even if inequality (5) is reversed, there are decaying states which are relatively stable around the cut off energy $\frac{2\hbar}{\tau}$.

This is the explanation for treating the pion as a bound state of an electron and a positron, as indeed is borne out by its decay mode. The situation is similar to the case of Bohr orbits– there also the electrons would according to classical ideas have collapsed into the nucleus and the atoms would have disappeared. In this case it is the discrete nature of space time which enables the pion to be a bound state as described by (1).

Another imprint of discrete space time can be found in the Kaon decay puzzle, as pointed out by the author[11]. There also we have equations like (2) and (3) above, with the energy term being given by $E(1+i)$, due to the fact that space time is quantized. Not only is the fact that the imaginary and real parts of the energy are of the same order is borne out but as pointed out in[11] this also explains the recently observed[12] decay and violation of the time reversal symmetry which in the words of Penrose[13], "the tiny fact of an almost completely hidden time-asymmetry seems genuinely to be present in the K^0-decay. It is hard to believe that nature is not, so to speak, trying to tell something through the results of this delicate and beautiful experiment."

From an intuitive point of view, the above should not be surprising because time reversal symmetry is based on a space time continuum and is no longer obvious if space time were discrete.

References

[1] Bombelli, L., Lee, J., Meyer, D., Sorkin, R.D., Phys. Rev. Lett. 59, 1987, 521.

[2] Wolf C., Nuovo. Cim. B 109 (3), 1994, 213.

[3] Lee, T.D., Phys. Lett. 12 (2B), 1983, 217.

[4] Sidharth, B.G., Ind. J. Pure and Applied Phys., 35 (7), 1997, 456.

[5] Sidharth, B.G., IJMPA, 13 (15), 1998, 2599. Also xxx.lanl.gov quant-ph 9808031.

[6] Sidharth, B.G., Chaos, Solitons and Fractals, 11 (8), 2000, 1269-1278.

[7] Sidharth, B.G., Chaos, Solitons and Fractals, 11 (8), 2000, 1171-1174.

[8] Sidharth, B.G., and Lobanov, Yu Yu, Proceedings of Frontiers of Fundamental Physics, (Eds.)B.G. Sidharth and A. Burinskii, Universities Press, Hyderabad, 1999.

[9] B.G. Sidharth, Mod.Phys. Lett. A., Vol. 12 No.32, 1997, pp2469-2471.

[10] B.G. Sidharth, Mod.Phys. Lett. A., Vol. 14 No. 5, 1999, pp387-389.

[11] Sidharth, B.G., Chaos, Solitons and Fractals, 11, 2000, 1045-1046.

[12] Angelopoulos, A., et al., Phys. Lett. B 444, 1998, 43.

[13] Hawking, S., Israel, W., General Relativity: An Einstein Centenary Survey, Cambridge University Press, Cambridge, 1979.