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Theory of quantum simulation of δ-functions in quantum electrodynamics

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In this paper is shown that the abstract Dirac-Delta function can be simulated through quantum mechanics. For this end the construction of Bessel profiles is a must for the quantum simulation. Consider below the transition amplitude S and LIPS the Lorentz invariant at the phase space:

$$\mathcal{S} = \int d^4p \times \mathcal{LIPS} \times \delta^4(p+k-q+k') = \int d^3p \times \mathcal{LIPS} \times \delta^3(p+k-q+k') \times \delta$$

$$\delta = \int dt\ Exp[-iab[Sin(x)Cos(y) - Cos(x)Sin(y)]]Exp[-icd[Sin(w)Cos(z) - Cos(w)Sin(z)]]$$

$$\delta = \int dt\ Exp[-iab(x-y)]Exp[-icd(w-z)] = \int dt \sum_{m}^{\infty} J_m(ab)Exp[-im(x-y)] \sum_{n}^{\infty} J_n(cd)\,Exp[-in(w-z)]$$

Dirac – Delta proportional to integer order Bessel functions

$$\delta = \int dt \sum_{m,n}^{\infty} J_m(ab)J_n(cd)Exp[-i(x+w-y-z)]$$

In according to R. P. Feynman: One can employ a quantum mechanics model to carry out a quantum simulation of a phenomenon. In this manner the quantum mechanics model can be the Compton scattering. In experiments one measures the Cross Section as function of energies.

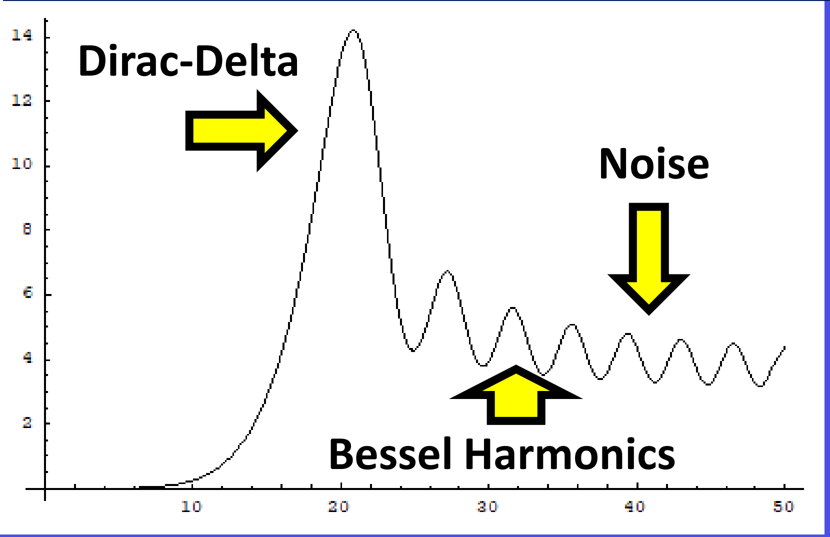
The time-dependent of Dirac-Delta then can be written as an infinite sum of Bessel functions.

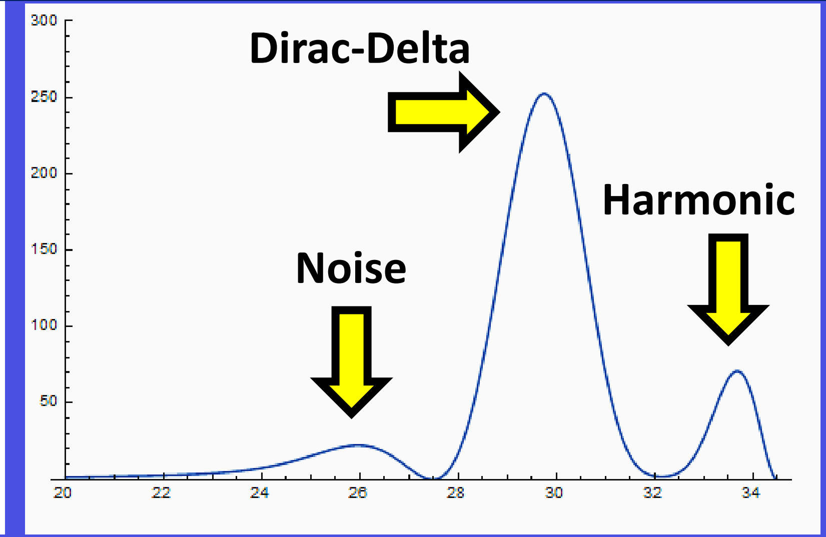
$$\boldsymbol{\delta = \int dt \sum_{m,n}^{\infty} J_m(ab) J_n(cd)}$$

Proposal of quantum simulation
σ is measured from experiment and it contains a well-defined background and S the theoretical amplitude

$$\sigma = \frac{|S|^2\,\delta^2}{VT} \quad \Rightarrow \quad \frac{\sigma}{\frac{|S|^2}{VT}} = \delta^2 \Rightarrow \delta = \sqrt{\frac{\sigma + \text{Background}}{\frac{|S|^2}{VT}}}$$

The computational simulations have assumed a low-noise data of electron-photon scattering (linear Compton scattering). In order to recognize the Dirac-Delta behavior, the large peak should exhibit a value greater the secondary peaks.





CONCLUSION

In this paper it was proposed the quantum simulation of Dirac-Delta function from the quantum system given by the electron-photon interaction. The resulting spectra show that peaks after noise rejection is a manifestation of Dirac-Delta.