The zero-point radiation field and de Broglie's wavelength; the infinite potential well as a case study

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We approach the simple problem of an electron in an infinite potential well, subject to the action of the random zero-point radiation field (ZPF) [1]. Despite the fully classical approach, the results compare favorably with the quantum ones, helping to throw light on the physics underlying the (formal) quantum solution. First the high-frequency modes are seen to induce a permanent jittering motion of the electron that endows it with an effective structure of the order of Compton's wavelength. The resonant response of the particle to the field modes of Compton's frequency gives rise to a modulated electromagnetic wave that accompanies the electron in its trajectory and has a wavelength equal to de Broglie's $\lambda_B = h/mv$. When the electron is confined within two parallel impenetrable walls a distance a apart, stationary states are obtained, with a probability distribution having maxima and minima, and discrete values for the mean velocity $v_n = (h/ma)n$. The connection of the ZPF with de Broglie's wave and the related wavelike behavior of the electron is thus elucidated.

[1] L. de la Peña, A. M. Cetto and A. Valdés (2015), The Emerging Quantum. Springer Verlag, Berlin, Ch. 9.