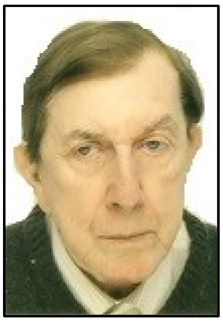
X-ray emission in LENR by Zero Point Energy or simple QED?



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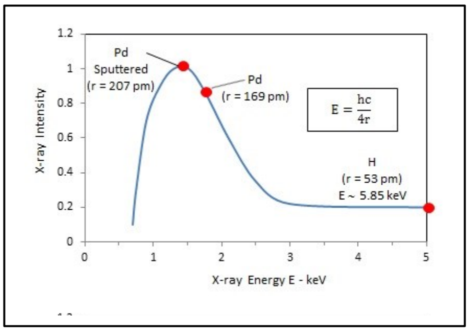
Introduction In 1900, Planck explained the radiation spectrum of a black body by treating the absorption of energy as discrete, but later assumed an average absorption energy E_{av} between (n-1) and n quantum levels, i.e., $E_{av} = ½ [nh\nu + (n-1)h\nu] = ½ [2n - 1] h\nu$. In the ground state, n = 1 and therefore E_{av} = ZPE = ½ hν. But the energy supplied to the atom may have any value between quantum levels, i.e., ZPE ≠ ½ hν, but rather ZPE < hν. Hence, the claim [1] the ZPE exists at MeV levels to explain the X-ray bursts [2] is questionable as the ZPE can only be less than the X-ray energy. In this paper, the ZPE of the atom is treated as a temporary state between quantum levels and not a quantum state of the atom. The X-ray bursts are explained by another mechanism.

Proposal The X-ray bursts in glow discharge [2] are produced by the simple QED quantum state. Simple QED is a consequence of QM that by Planck's law requires the heat capacity of the atom to vanish under high EM confinement. QM stands for quantum mechanics. Since QM denies atoms heat capacity, heat Q into the atom does not increase temperature. But atoms have high surface-to-volume ratios that requires deposition of heat Q to be almost entirely in the atom surface. Precluded from thermal expansion, the surface heat Q_s places the atom under the high EM confinement necessary in the Planck law for heat capacity to vanish. Absent heat capacity, the simple QED transition to X-ray levels occurs by converting the surface heat Q_s to non-thermal EM energy within the atom that depends solely on the atom dimensions, i.e., independent of electron energy levels. Provided the heat Q_s is deposited promptly, photons standing inside the atom are created having half-wavelength $\lambda/2 = 2r$, where r is the atomic radius. The Planck energy E of the photon standing in the atom is, $E = h\nu = hc/\lambda = hc/4r$, where c is the speed of light. If the surface heat Q_s is sufficient to reach the X-ray level, the X-ray is emitted. If not, the Q_s heat resides in a temporary state of the atom. Unable to make the X-ray transition, the Q_s heat is promptly re-emitted as EM radiation at frequency ν to combine with radiation from other atoms to make the X-ray transition. See simple QED applications: http://www.nanoqed.org/, 2010 – 2018.

Application The X-ray emission from glow discharge with Pd atoms in (Fig. 18 of [2]) is reproduced in the thumbnail. For Pd having radius r = 169 pm, simple QED gives E = 1.83 keV and wavelength λ = 0.676 nm. The X-ray peak occurs at 1.5 keV because sputtering creates Pd clusters not necessarily perfectly bare Pd atoms. Taking the classical heat flow Q from the glow discharge temperature T into the atom is, $Q = \pi r^2 HT$, where H = 5.67 W/m^2K is the convection heat transfer coefficient, and T the plasma temperature. For T = 1 eV = 11,500 K, Q = 5.85 x 10^{-15} J/s. The time τ for an individual atom to reach the X-ray level is, τ = E/Q = 50 ms, but X-ray transitions require τ < 150 fs. To induce the transition, Q > Q*, where Q* = E/150 fs = 1.95 x10^{-3} J/s. X-ray emission at heat flow Q < Q* requires a cooperative effect. For a collection of N_t atoms, a variant of the Dicke state based on the QM description of single photon absorption of heat Q from the cathode and subsequent superradiant re-emission in the same direction. In effect, the atoms cooperate by redistributing the surface heat Q_s from N_t atoms into a smaller number N having the necessary surface heat Q* to make the X-ray transition. From (Fig. 4(b) of [2]), N is the number of X-ray photons/burst ~ 1.6 x 10^8. Since N_t/N = 50 ms/150 fs ~ 3.33 x 10^{11}, a large number of N_t atoms are required to emit a single X-ray photon. When the glow discharge is turned off, the Pd atoms are still at temperature T_C of the cathode which decays slowly. Since T_C < T, the heat Q is decreased, but the X-ray emission still occurs.



Conclusion Simple QED with superradiance explains X-rays in LENR without the ZPE or nuclear reactions.

References

[1] B. I. Ivlev, " Conversion of zero point energy into high-energy photons," Revista Mexicana de F´ısica, 62, 83-88, 2016.

[2] A. B. Karabut, E. A. Karabut, P. L. Hagelstein, "Spectral and Temporal Characteristics of X-ray Emission from Metal Electrodes in a High-current Glow Discharge," J. Condensed Matter Nucl. Sci. 6, 217–240, 2012.