PHYSICAL REVIEW D VOLUME 35, NUMBER 10 15 MAY 1987

Ground state of hydrogen as a zero-point-fluctuation-determined state

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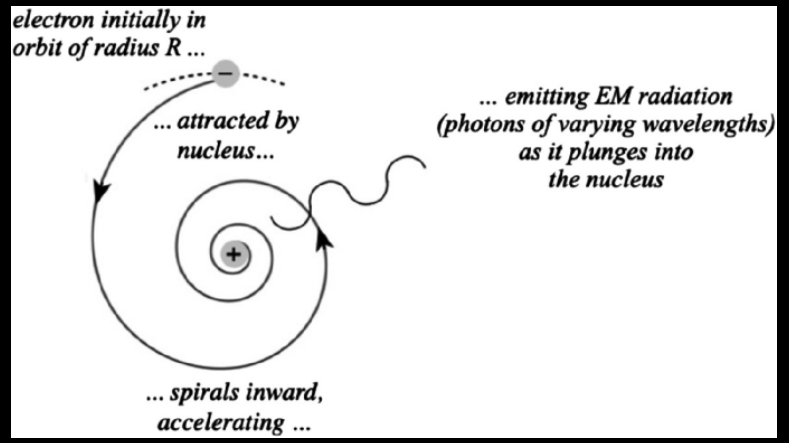
(Received 22 December 1986)

Walkthrough by AnthonyMakesVideos

What is this paper about?

"I have so far not dealt with the important question of the distribution of the external electrons which make up the atom. It is obvious there are great difficulties on the ordinary mechanics in considering possible distributions, for there is no reason why an electron if disturbed should not always fall into the nucleus."
– Rutherford, 1914

- The core derivation equates time-averaged radiated power to absorbed zero-point fluctuation (ZPF) power
- This leads to the equilibrium radius of the ground (unexcited) state hydrogen atom (1 proton + 1 electron) and the $m\omega r^2 = \hbar$ relation at the level of theory of the Bohr atom
- Puthoff's derivation is conceptually grounded on Timothy H. Boyer's Stochastic Electrodynamics (SED)
- SED incorporates a stochastic (random) background EM field (ZPF) to reproduce many quantum phenomena *classically* without the typical quantization of matter or fields



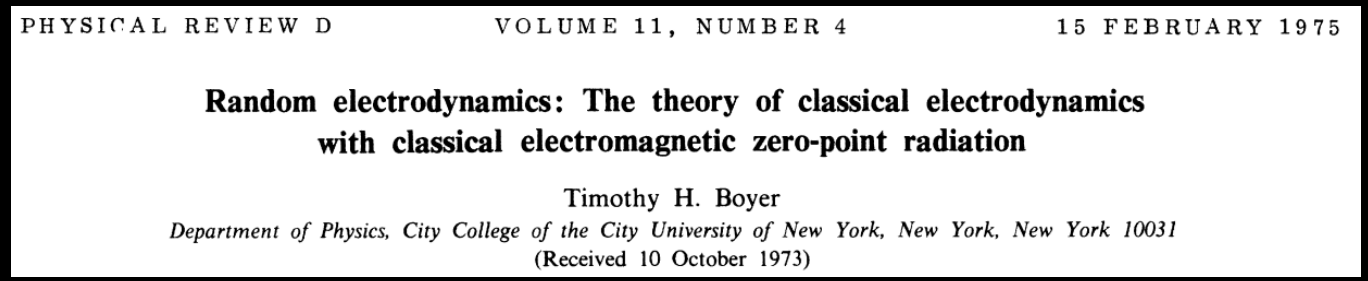
TL;DR

- Within SED, the hydrogen ground state can be modeled as a dynamic power-balance equilibrium.
- At the semi-classical Bohr level (circular orbit), the electron undergoes centripetal acceleration and radiates according to the Larmor formula.
- However, it continuously absorbs energy from the fluctuating ZPF via the dipole interaction.
- Setting the time-averaged absorbed power equal to the radiated power yields a stable equilibrium precisely at the Bohr ground-state parameters: radius a_0, frequency ω, and angular momentum $m\omega r^2 = \hbar$ (n=1).
- This resolves the classical radiative instability (spiral-in collapse) without ad-hoc quantization.
- The derivation parallels QED results for linear systems and shows the ZPF as causally responsible for preventing collapse.

Background on 🦉 ~~Owl Hootoff~~ 🦉 Hal Puthoff

- MD at Institute for Advanced Studies Austin
- 3 eras of research:
  - Quantum Electronics (60s – 70s)
  - Parapsychology & Remote Viewing (70s – 80s)
  - ZPE, (anti-)gravity/general relativity, stochastic electrodynamics, advanced propulsion (90s – present)
- 78 public publications; 2,727 citations
- Selected works:
  - **Ground state of hydrogen as a zero-point-fluctuation-determined state (1987)**
  - Gravity as a zero-point-fluctuation force (1989)
  - Physics of the zero-point field: Implications for Inertia, Gravitation and Mass (1997)
  - DIRD 15: Advanced Space Propulsion Based on Vacuum (Spacetime metric) Engineering (2010)
  - Frontiers of Propulsion Science (Edited by Marc Millis & Dr. Eric W. Davis, 2009) Chapter 18: On Extracting Energy from the Quantum Vacuum

Tenets of SED



PHYSICAL REVIEW D VOLUME 11, NUMBER 4 15 FEBRUARY 1975

Random electrodynamics: The theory of classical electrodynamics with classical electromagnetic zero-point radiation

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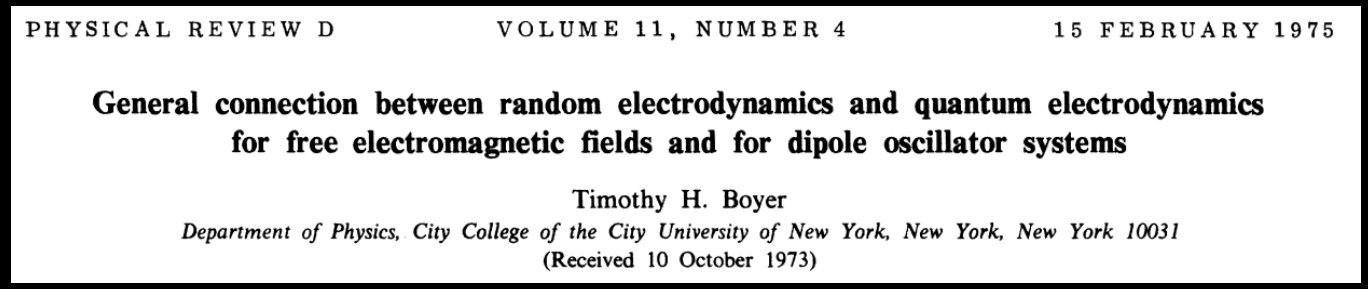
(Received 10 October 1973)



PHYSICAL REVIEW D VOLUME 11, NUMBER 4 15 FEBRUARY 1975

General connection between random electrodynamics and quantum electrodynamics for free electromagnetic fields and for dipole oscillator systems

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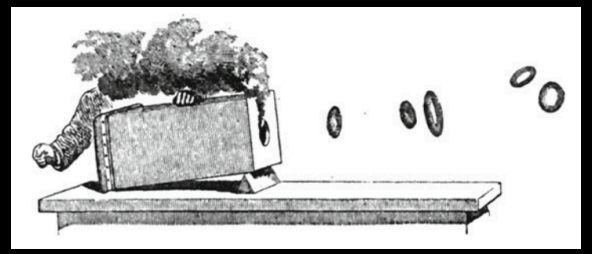
(Received 10 October 1973)

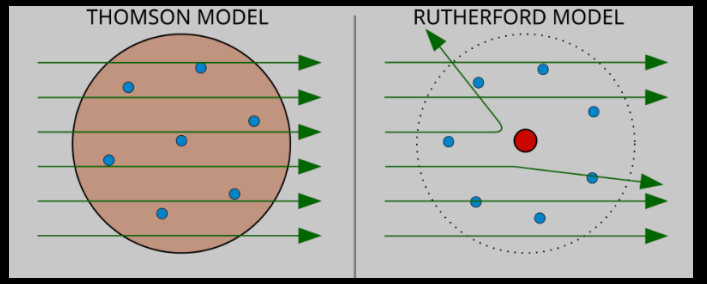
- Classic Maxwellian EM holds
- The vacuum is filled with a random classical zero-point radiation which is homogeneous, isotropic, and Lorentz invariant
- Interactions between charged particles and the fluctuating ZPR produces effects that mimic those from quantum mechanics
- Statistically equivalent to quantum electrodynamics (QED) in many regimes

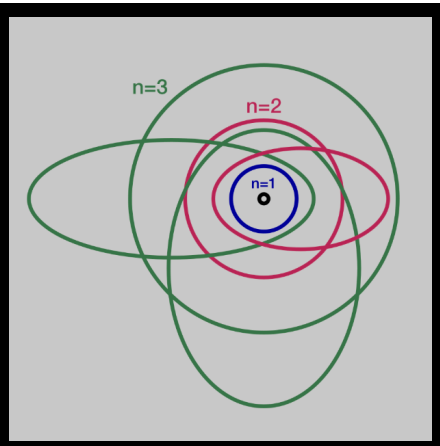
Models of the atom (very abridged)

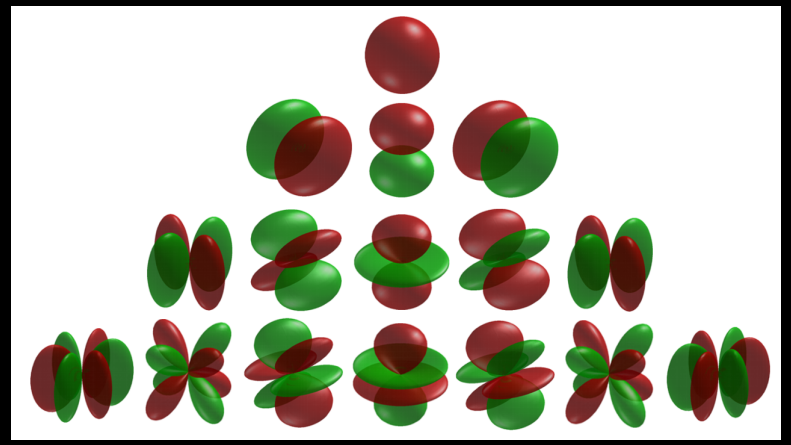
- Knots & vortices in the æther
- JJ Thomson's "plum pudding" (he didn't call it that; misnomer)
- Joseph Larmor & the classical planetary model
- **Bohr model**
- Spherical Schrödinger equation solution based electron orbitals
- Discovery of the neutron,

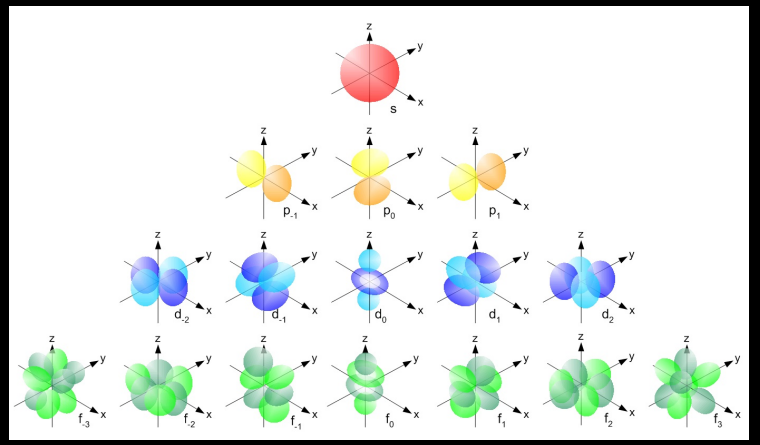
  etc. …

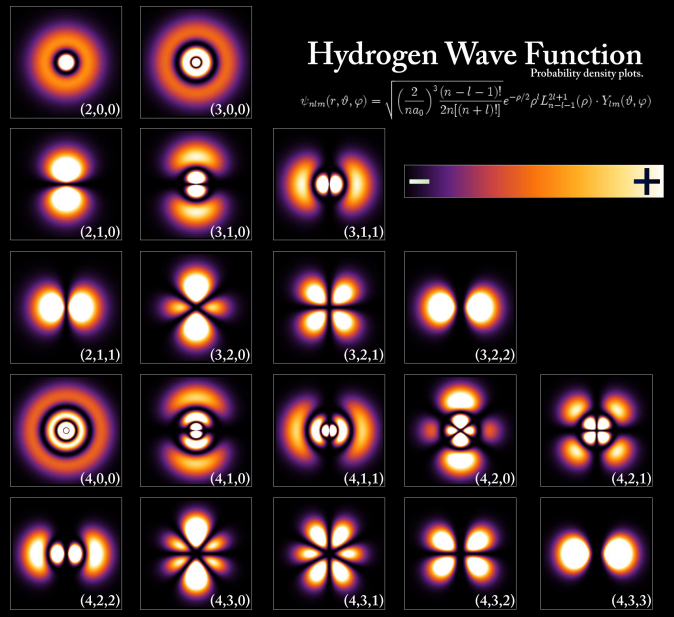






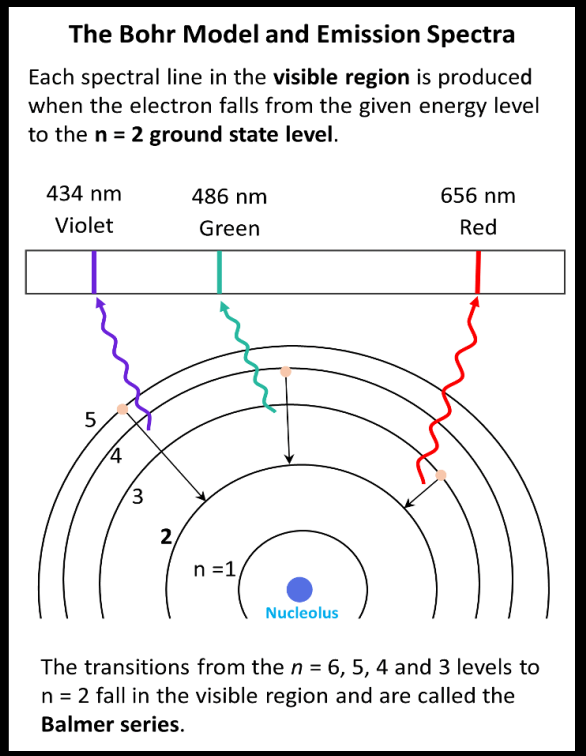






Why don’t electrons decay into the nucleus? (I)

- Bohr model
  - Orbits are quantized & closed
  - No energy could be lost while the electron is in orbit
  - Spectral lines from excited atoms = transitions between orbits
  - However, the hydrogen atom isn’t flat and particles embody 3D space (i.e., aren’t precisely points)



Why don’t electrons decay into the nucleus? (II)

- From Heisenberg Uncertainty:
  - Abandon the idea that subatomic particles have well-defined trajectories in space
    - Wave-particle duality of *matter* (e.g., Davisson Germer experiment)
  - Confining an electron to a smaller space drastically increases its momentum and kinetic energy uncertainty
  - Extreme confinement (i.e., collapse into the nucleus) triggers massive kinetic energy
  - This creates an outward “quantum pressure” that overwhelms the Coulombic electrostatic attraction

$$\Delta x \cdot \Delta p \geq \frac{\hbar}{2}$$

- If the electron falls into the nucleus

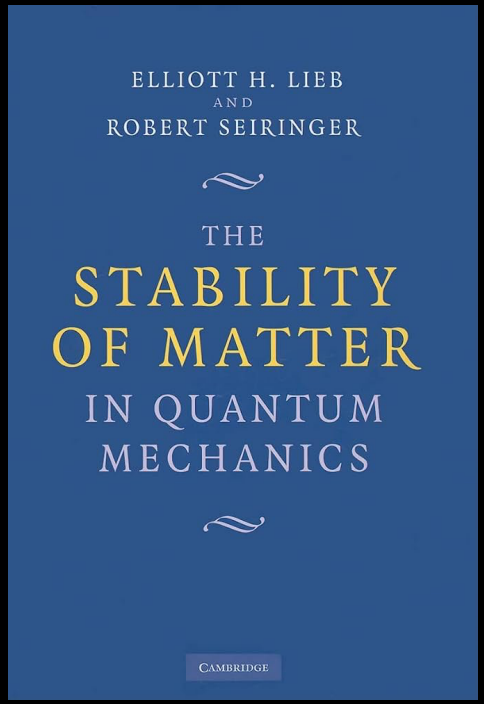
$\Rightarrow \Delta x$ shrinks ~size of a proton

$\Rightarrow \Delta p$ becomes enormous

$\Rightarrow$ High Δp outweighs the attractive Coulombic electrostatic force between the electron & proton, preventing the electron from decaying into the nucleus

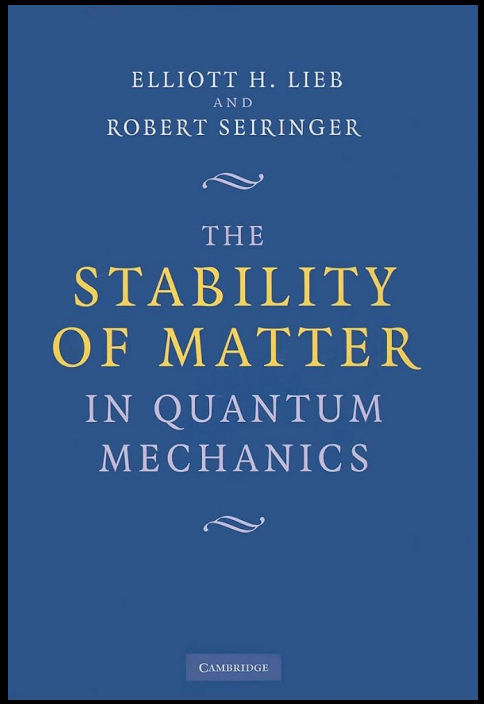
Why don’t electrons decay into the nucleus? (III)

- Stability against a collapse of the electron's wavefunction: the electron’s wavefunction becomes bounded within an arbitrarily small distance from the proton
- Stability against the electron’s escape; assumes a point-like proton
  - Since protons are not really point-like, compressing the electron to an arbitrarily small space ϵ near the center of the proton gives an electric field whose energy diverges to infinity like $1/\epsilon$.
  - If the proton were truly point-like, then the external field would go to zero in this limit, so this argument would fail.



Why don’t electrons decay into the nucleus? (IV)

- Consider the fine structure constant, $\alpha = ke^2/\hbar c \approx 1/137$, and the Bohr radius, $a_o = \hbar/mc\alpha$, where m is the mass of the electron.
  - In hydrogen, the typical velocity of the electron is αc, and since this is small compared to c, you don't really need quantum field theory for hydrogen.
  - The Schrodinger equation, which is nonrelativistic, makes an excellent approximation in this case.
  - However, if you consider a hydrogen-like atom consisting of a nucleus with atomic number Z plus a single electron, the velocity in units of c is on the order of $Z\alpha$.
  - For large Z, this shows that you need relativity *and* quantum field theory.



Summary of the Puthoff's derivation

1. SED formulations for the E-field (2) and H-field (3)
2. Substitute (2) into a nonrelativistic equation of motion (4) along the x-axis for a 1D charged harmonic oscillator with mass m, natural frequency ω_0, charge e initially at the origin immersed in ZP radiation & including radiation dampening

   $\Rightarrow$ Displacement (5), velocity (6) equations
3. Calculate the average power absorbed from the zero-point background using (2) & (6) => $\langle P^{abs} \rangle$ (9)
4. Simplify (9) into (10) by averaging over random phases given by (11)
5. Use $\int d^3\mathrm{k}$ -> $\int d\Omega_\mathrm{k} \int dk\ k^2$ to rewrite (10) as (12)

Summary of the Puthoff's derivation (cont'd)

6. The sum over polarizations given by (13) transforms the angular integration in k term in (12) into (14). Substituting (14) into (12) and taking the change of variables $\omega = kc$ yields (15)
7. Small Γ => integrand of (15) is sharply peaked around $\omega = \omega_0$

   => invoke resonance approximation => extend limits of integration

   => replace ω by ω_0 everywhere except the difference term => (16)
8. a. Bohr theory ground state pair of 1D harmonic oscillators in a plane (17) => Power absorbed from background by an electron in a circular orbit (18)

   b. Power radiated by an electron in a circular orbit with acceleration A (19)

Boyer's hypothesis => equate (18) & (19)

=> $m\omega_0 r_0^2 = \hbar$