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ON THE FEASIBILITY OF CONVERTING VACUUM ELECTROMAGNETIC ENERGY TO USEFUL FORM

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We begin by arguing briefly that the zero-point energy (ZPE) spectrum is real, rather than virtual, and can be traced to an Olbers-type radiation originating with the fluctuating motion of charged particles distributed throughout the universe. This interpretation in its present form derives from the suggestion put forward by de la Peña in his 1982-83 review,[1] the development by myself in 1989,[2] and the correction by Santos in 1991.[3]

Having established a basis for the reality of the ZPE, it then becomes a meaningful question as to whether the ZPE can be "mined" for practical use, that is, extracted to perform useful work. As discussed by Rueda, just such processes might already occur in Nature in certain large-scale, energetic astrophysical phenomena.[4]

With regard to laboratory experimentation, the candidate mechanism for energy extraction is the Casimir effect, as emphasized by Forward in his paper *Extracting Electrical Energy from the Vacuum...*[5] In its primitive form, ZPE extraction occurs as freely-moving conducting plates convert the attractive Casimir (vacuum) potential energy first into kinetic energy, then heat as the plates collide. In an alternative embodiment envisioned by Forward, the plates are electrically charged with the same-sign charge, resulting in a buildup of Coulomb energy as the stronger attractive ($1/d^4$) Casimir force overcomes the weaker Coulomb repulsion at small spacing and draws the charged plates together. These approaches, while admittedly impractical for significant, continuous energy generation, nonetheless demonstrate the basic principle involved. Furthermore, although it might be natural to assume that such attempts to extract energy or heat from the vacuum at temperature $T = 0$ might somehow violate thermodynamic constraints (as in misguided attempts to

extract energy from a heat bath under equilibrium conditions), a careful analysis due primarily to Cole shows that this is not the case, and that energy and heat can in principle be extracted.[6]

A combination of theoretical and experimental work at our Institute indicates that yet another approach to obtaining energy from vacuum fluctuations might lie in a plasma variation of the Forward embodiment. This potentiality is based on emerging laboratory evidence that the Casimir effect may be a major contributing mechanism to the generation of high-density charge clusters in micro-arc discharges (which of itself has led to the development in our laboratory of a new, patented micro-electronics technology known as condensed-charge technology, CCT). In short, the generation of a relatively cold, dense, non-neutral (charged) plasma results in charge-con- densation effects that may be attributable to a Casimir-type pinch effect.

As applied to an hypothesized energy-generation process, one would envision a "Casimir-fusion" process, which in its cycle of operation would mimic the nuclear fusion process. It would begin, like its nuclear counterpart, with an initial energy input to a plasma to overcome a Coulomb barrier, followed by a condensation of charged particles drawn together by a strong, short-range attractive potential (in this case a Casimir rather than a nuclear potential), and with an accompanying energy release in some form. Should the energy requirements for plasma formation, and electrical circuit and heat losses be kept at a level below that required for break-even operation, then, as in the nuclear case, net useful energy could in principle be generated.[7] In support of this possibility, first-order modeling of the process will be presented, along with discussion of observed anomalous laboratory observations. These include preliminary attempts at calorimetry measurement of possible excess heat generation at the tens-of-milliwatt level that are ongoing in our laboratory, but which require further effort to confirm.

1. L. de la Peña, *Stochastic Electrodynamics: Its Development, Present Situation and Perspectives*, in *Proceedings of the Latin American School of Physics*, Cali, Colombia, 1982, edited by B. Gómez *et al.* (World Scientific, Singapore, 1983).

2. H.E. Puthoff, *Source of Vacuum Electromagnetic Energy*, Phys. Rev. **A40**, 4857 (1989).

3. E. Santos *Comment on 'Source...'*, Phys. Rev. **A44**, 3383 (1991). See also H.E. Puthoff, *Reply to Comment on 'Source...'*, Phys. Rev. **A44**, 3385 (1991)

4. A. Rueda, Space Sci.Rev. **53** (3/4), 223 (Kluwer Academic Publ., 1990).

5. R.L. Forward, *Extracting Electrical energy from the Vacuum by Cohesion of Charged Foliated Conductors*, Phys. Rev. **B30**, 1700 (1984).

6. D.C. Cole and H.E. Puthoff, *Extracting Energy and Heat from the Vacuum*, Phys. Rev. **E**, subm. (1993).

7. H.E. Puthoff, *The Energetic Vacuum: Implications for Energy Research*, Spec. in Sci.and Tech. **13**, 247 (1990). See also *Zero-Point Energy: An Introduction*, Fusion Facts **3**, no. 3, 1 (1991).