Dirac's particle

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In **literally nothing** not even spacetime exists—there is no universe. Today, we observe a universe full of matter and energy.

[In 1982, Alexander Vilenkin writes: *A cosmological model is proposed in which the universe is created by quantum tunneling from literally nothing into a de Sitter space.* See Phys. Lett. 117B, 25. The de Sitter space *describes a universe which is contracting at* $t < 0$*, reaches its minimum size at* $t = 0$*, and is expanding at* $t > 0$*.*]

Occam's razor (which is a special case of the more general **principle of maximum simplicity**) suggests that, when time begins and the universe is born, the universe should contain as few particles as possible, with as few forces as possible acting between the particles. Similarly, as few symmetries as possible should be broken in the spontaneous transition from literally nothing to material universe.

Therefore, a particle pair (e.g. an electron-positron pair) is no ideal candidate for the first "prototype particle." Instead, one would expect that the universe first appears in the form of a single-particle spacetime bubble with neither electric charge nor spin disturbing the symmetry.

Forces act between particles and are mediated by particles (gauge bosons). For instance, the force between an electron (e^-) and a positron (e^+) is mediated by a third particle—the photon (γ). Naturally, there can be no forces in a single-particle universe.

Thus, a universe beginning as a single, neutral and spinless particle fulfills the requirements of Occam's razor.

Dirac's new equation

In 1971, Paul Dirac published a paper titled **A positive-energy relativistic wave equation** (Proc. R. Soc. Lond. A322, 435).

Dirac writes: *A new relativistic wave equation for particles of non-zero rest-mass is here proposed, allowing only positive values for the energy. There is great formal similarity between it and the usual relativistic wave equation for the electron, but the physical significance is very different.*

Physicists never found any use for Dirac's "new equation" and soon forgot it. Apparently, no one realized how well Dirac's particle is suited for playing the role of the first prototype particle.

The fact that *one may try the usual way of introducing an electromagnetic field* only to find that *the equations are no longer consistent* means that the "D particle" is unable to produce virtual photons and therefore cannot interact with another particle or reproduce itself in any form—neither real nor virtual. Thus, the D particle is doomed to spend its life alone in its universe.

In 1973, L. C. Biedenharn, M. Y. Han, and H. van Dam published a paper titled **Generalization and Interpretation of Dirac's Positive-Energy Relativistic Wave Equation** (Phys. Rev. D 8, 1735).

The authors state that *the new Dirac equation and its generalization may be consistently viewed as composites of two subparticles interacting via action-at-a-distance forces.* Further, they explain that viewing the *new Dirac equation* as a *realization on two bosons,* one *must assume that one or both of the two subparticles will bear electric charge.*

Thus, it seems plausible that the simple, neutral and spinless D particle should be able to transform into a pair of charged bosons ("spinless tauons," say), thereby creating the first prototype bosons (τ_0^- and its antiparticle τ_0^+). These spinless tauons may, in turn, annihilate each other to create the first prototype photon (γ_τ). Consequently, the D particle may decay into pure radiation via the process $\mathrm{D} \to \tau_0^+\tau_0^- \to \gamma_\tau\gamma_\tau$.

In a very real sense, the new Dirac equation constitutes an explicit and precise solution to the relativistic harmonic oscillator. This fact suggests that the Dirac particle also may decay directly via the process $\mathrm{D} \to \gamma_\tau\gamma_\tau$, which is irreversible because Dirac's particle *cannot interact with the electromagnetic field without destroying the consistency of the defining structure.*

Since the spinless tauon has the ability to reproduce itself by emitting a pair of photons that recombine to form another spinless-tauon pair, cloning of particles becomes possible in the expanding universe once the D particle has transformed into a pair of spinless tauons.

It should be stressed that the question of how new particles appear on the horizon of the expanding universe is in no way specific to predictive cosmology. The same problem appears in all big-bang models in which the universe undergoes a phase of initial expansion.