Review of: "Mass Creation via the Phase Transition of the Higgs Field"

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Potential competing interests: No potential competing interests to declare.

I have completed my review of the manuscript titled "Mass Creation via the Phase Transition of the Higgs Field" by Dimitris M. Christodoulou and Demosthenes Kazanas. The paper aims to present a novel theoretical approach to understanding the Higgs mechanism, proposing a first-order phase transition due to explicit symmetry breaking in the Higgs potential. While the subject is of significant interest, I have several reservations regarding the foundational assumptions and interpretations presented in the paper.

Summary of the Paper: The authors challenge the conventional view of the Higgs potential, arguing that the commonly accepted bistable potential is flawed. They propose that the Higgs field undergoes a first-order phase transition with explicit symmetry breaking in the potential. The paper critiques Landau's theory of phase transitions and applies catastrophe theory to propose a new form of the Higgs potential, suggesting significant implications for our understanding of mass generation in particle physics.

Critical Evaluation:

Misinterpretation of Spontaneous Symmetry Breaking (SSB): The authors' interpretation of SSB appears to misunderstand its basic principles. SSB, a cornerstone in the standard model of particle physics, implies that while the governing laws (or the potential) retain their symmetry, the ground state of the system does not exhibit this symmetry. This aspect seems to be overlooked or misinterpreted in the paper.

Questionable Assumption of Explicit Symmetry Breaking: The paper's foundational assumption of explicit symmetry breaking in the Higgs potential is problematic. In the standard model, the Higgs potential's symmetry is enforced by gauge invariance, a crucial aspect that cannot be violated. The paper does not provide a justification for deviating from this well-established principle. The Higgs field, being charged under the gauge group, plays a fundamental role in electroweak symmetry breaking and fermion mass generation, making the explicit breaking of this symmetry an unjustified and unsupported proposition in the given context.

Lack of Novelty in the Proposed Transition Change: The assertion that explicit symmetry breaking modifies a second-order transition to a first-order one is a well-known fact and does not constitute a novel contribution to the field. This textbook-level understanding does not warrant the claims of groundbreaking theoretical advancement presented in the manuscript.

Conclusion: In light of the above points, the manuscript fails to substantiate its claims with rigorous theoretical justification and overlooks fundamental aspects of the standard model and the Higgs mechanism. The proposed model, deviating from the established gauge invariance without substantial justification, does not add new knowledge to the existing body of research in high-energy physics. Therefore, I cannot recommend this paper for publication in its current form. It requires significant revision and a more thorough grounding in the established principles of particle physics to be considered a valuable contribution to the field.