

A Classical Derivation of Planck's Formula from Electromagnetic Mode Merging Statistics

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Abstract

This work presents a classical derivation of Planck's blackbody radiation law using merging dynamics of electromagnetic field modes. The field is modeled as a web of spiral-vortical filaments — structured flows of energy that interact resonantly. Without invoking quantum postulates, the statistical merging of such modes yields a spectral energy distribution identical to Planck's formula, while resolving the ultraviolet catastrophe through an emergent exponential factor.

1. Introduction

Historically, Planck's law emerged from a quantization assumption he described as an “act of desperation.” The law's exponential dependence on frequency has stood as a cornerstone of quantum theory. This paper proposes a fully classical interpretation, wherein the modes of the electromagnetic field — structured as filaments with spiral-vortical geometry — interact statistically, producing discrete energy emissions as a natural consequence of merging behavior.

2. Electromagnetic Filament Structure

Electromagnetic field modes are modeled as spiral-vortical flows of substance: dynamic force filaments with helical geometry and periodic oscillation. These filaments span regions between atomic centers and carry energy proportionally to their curvature and frequency. The spatial length of a filament r is inversely proportional to its frequency ν ($r \sim 1/\nu$). When two such threads merge in resonance, they generate energy pulses with magnitudes $E = h \cdot \nu$, where h acts as a coupling scale constant, later equated with Planck's constant.

3. Statistical Merging and Energy Distribution

The likelihood of filament merging is thermally governed. For n merged pairs at temperature T , the probability is proportional to $\exp(-n \cdot h \cdot \nu / k \cdot T)$, where k is Boltzmann's constant. Averaging over all such interactions yields the average energy per mode:

$$= h \cdot \nu / [\exp(h \cdot \nu / k \cdot T) - 1]$$

This mirrors Bose–Einstein statistics, but arises from classical thermodynamic interaction, not quantum mechanics.

4. Spectral Energy Density

The number of field modes per frequency interval $[\nu, \nu + d\nu]$ in volume V is:

$$(8 \cdot \pi \cdot V \cdot \nu^2 \cdot d\nu) / c^3$$

Multiplying by the average energy gives the spectral density:

$$u(\nu, T) = (8 \cdot \pi \cdot h \cdot \nu^3) / [c^3 \cdot (\exp(h \cdot \nu / k \cdot T) - 1)]$$

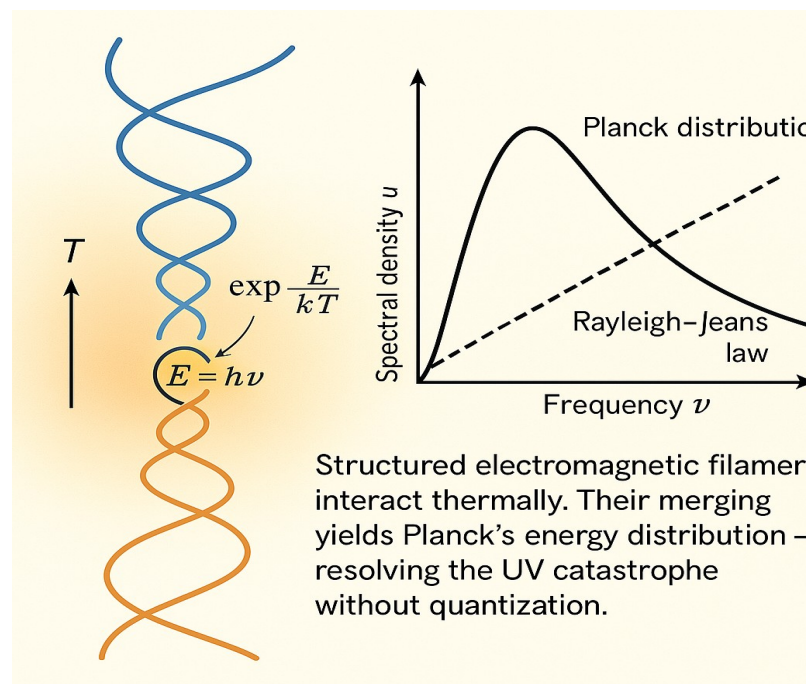
This is Planck's exact formula — derived without quantum postulates.

5. Resolution of the Ultraviolet Catastrophe

Unlike the Rayleigh–Jeans law, which predicts a divergent energy density at high frequencies, the exponential factor derived from filament merging suppresses excessive contributions, ensuring convergence. The catastrophe is resolved via classical structure and thermodynamic dynamics.

6. Conclusion

Electromagnetic field filaments, modeled as spiral-vortical threads, offer a classical basis for mode merging that reproduces Planck's radiation law. This resonance-based framework replaces quantum discontinuity with structured thermodynamic behavior — suggesting an underlying layer of classical order within seemingly quantum phenomena.



With the help of AI.