

One Problem:

Working alone in your laboratory late at night, you discover incontrovertible proof that the Coulomb's law Maxwell equation is wrong. The correct expression, you determine, is

$$\nabla \cdot \left(\mathbf{E} + \tau \frac{\partial \mathbf{E}}{\partial t} \right) = \frac{\rho}{\epsilon_0}$$

where $\tau \approx 10^{-24}$ s. Conservation of charge remains valid, however.

- (a) Does your discovery invalidate any of the other Maxwell equations? If so, which one? Propose a revised form for that Maxwell equation. If you have to make a choice, make the simplest one.
- (b) Consider a plane electromagnetic wave propagating in the x -direction through a vacuum, with everything proportional to $\exp[i(kx - \omega t)]$, where ω is real. Does the wave grow or decay as it propagates? What is the spatial e -folding rate for growth or decay, for waves with frequencies much less than $1/\tau$?