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## A finite model for electrodynamics by introducing a form factor $f_{HD_2}(\ell^2\Box)=1+\left(-\ell^2\Box\right)^2$ into the kinetic term of Maxwell theory

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## **Abstract**

In this paper, a higher-derivative model for electrodynamics is presented in a D+1 dimensional Minkowski space-time by introducing a form factor into the kinetic term of Maxwell theory as  $-\frac{1}{4\mu_0}F_{\mu\nu}F^{\mu\nu}\rightarrow -\frac{1}{4\mu_0}F_{\mu\nu}f_{HD_2}\left(\ell^2\Box\right)F^{\mu\nu}, \text{ where } \ell>0 \text{ is a characteristic length scale. Our calculations show that for } \ell>0$ 

 $D \in \{3,4,5\}$  the electrostatic potential of a point charge is finite at the position of the point charge in this higher-derivative modification of Maxwell's theory. For D=3 the explicit form of the potential and the electric field of a point charge are obtained analytically in this higher-derivative electrodynamics. According to numerical estimations, the upper bound for the characteristic length scale  $\ell$  is  $\ell_{\text{max}} \sim \frac{1}{100} \ell_{\text{electroweak}}$ ,

where  $\ell_{electroweak} = 10^{-18} m$  is the electroweak length scale. Finally, it should be emphasized that for  $\ell \ll 1$  the results of this paper are compatible with the results of ordinary Maxwell theory.

**Keywords:** Maxwell electrodynamics, regularization techniques, form factor, characteristic length scale, field theories with higher derivative terms

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