

# Possible Modification of Coulomb's law at Low Field Strengths

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## Abstract

Assuming that the analogy between Gravity and Electricity is universal, and that modification of gravity is favoured over modification of Newton's Second Law in order to solve the problem of flat galaxy rotation curves, I show that there exists a critical scale  $E_0 = a_0/\sqrt{4\pi\epsilon_0 G}$  for Electric field strength, which is approximately about 1.39 volts per meter. If the assumptions are sound, for field strengths well below this value Coulomb's law must be reconsidered.

**Keywords**— Critical Electric Field Strength, MOND, Milgrom's constant, Flat Galaxy Rotation Curves, Dark matter, Gravito-Electric Equivalence

The alternative resolution of the problem of galaxy rotation curves is to modify *either* Newton's Second Law, or Gravity. Due to problems with cherished fundamental principles of physics like conservation of energy, usually modification of gravity is preferred.

In the second form (modification of gravity), Milgrom-Bekenstein's proposal is to assume a *universal critical scale*  $a_0$  for the *gravitational field strength*[1], with

$$a_0 \approx 1.2 \times 10^{-10} \text{ ms}^{-2}. \quad (1)$$

Below this scale gravity 'changes behaviour' so as to make the rotation curves flat, eliminating the need for Dark matter.

In [2] I proposed the universal equivalence of gravity and electrostatics<sup>1</sup>, manifested by *Gravito-Electric transformation*,

$$M \rightarrow \frac{Q}{\sqrt{4\pi\epsilon_0 G}} \quad \text{and} \quad \phi \rightarrow -\sqrt{4\pi\epsilon_0 G}\varphi \quad (2)$$

which transforms Newtonian gravitational potential

$$\phi(r) = -\frac{GM}{r},$$

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<sup>1</sup>At least. An even stronger version was the 'Generalized Equivalence Principle' which included Magnetism as well.

into Coulomb potential

$$\varphi(r) = \frac{1}{4\pi\epsilon_0} \frac{Q}{r}.$$

Under this light, it is strongly suggested to ask whether like the case for gravity, a critical scale  $E_0$  for *electric field* might exist as well.

In the so-called ‘deep-MOND’ regime  $a \ll a_0$ , Milgrom-Bekenstein’s proposed gravitational potential is

$$\phi = \sqrt{GMa_0} \log r. \quad (3)$$

Applying transformation (2)

$$\boxed{\varphi = -\sqrt{\frac{E_0}{4\pi\epsilon_0}} Q \log r} \quad (4)$$

where

$$\boxed{E_0 = \frac{a_0}{\sqrt{4\pi\epsilon_0 G}}} \quad (5)$$

This means that well below the critical electric field strength

$$E_0 \approx 1.39 \text{ V/m},$$

Coulomb’s law *might* fail and give over to (4) instead.

Empirical falsification of this prediction will prove that at least one of the following assumptions wrong:

1. Universal analogy of Gravity and Electricity (Gravito-electric transformations)
2. The modification of Newton’s law of Gravitation is favoured over modification of Newton’s Second law

## References

- [1] B. Famaey and S. McGaugh. Modified Newtonian Dynamics (MOND): Observational Phenomenology and Relativistic Extensions. *Living Reviews in Relativity*, 15(10), 2012.
- [2] A. Jamali. Geometrisation of Electromagnetism. *viXra:2107.0132*, 2021.