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## Double unification of particles with fields and electricity with gravity under Aristotle's non-empty space can rid of Coulomb divergences and metric singularities.


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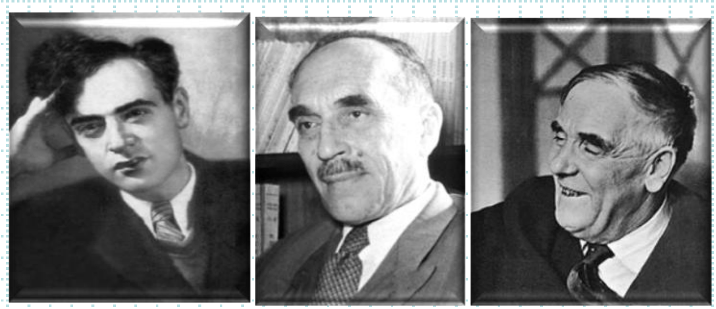

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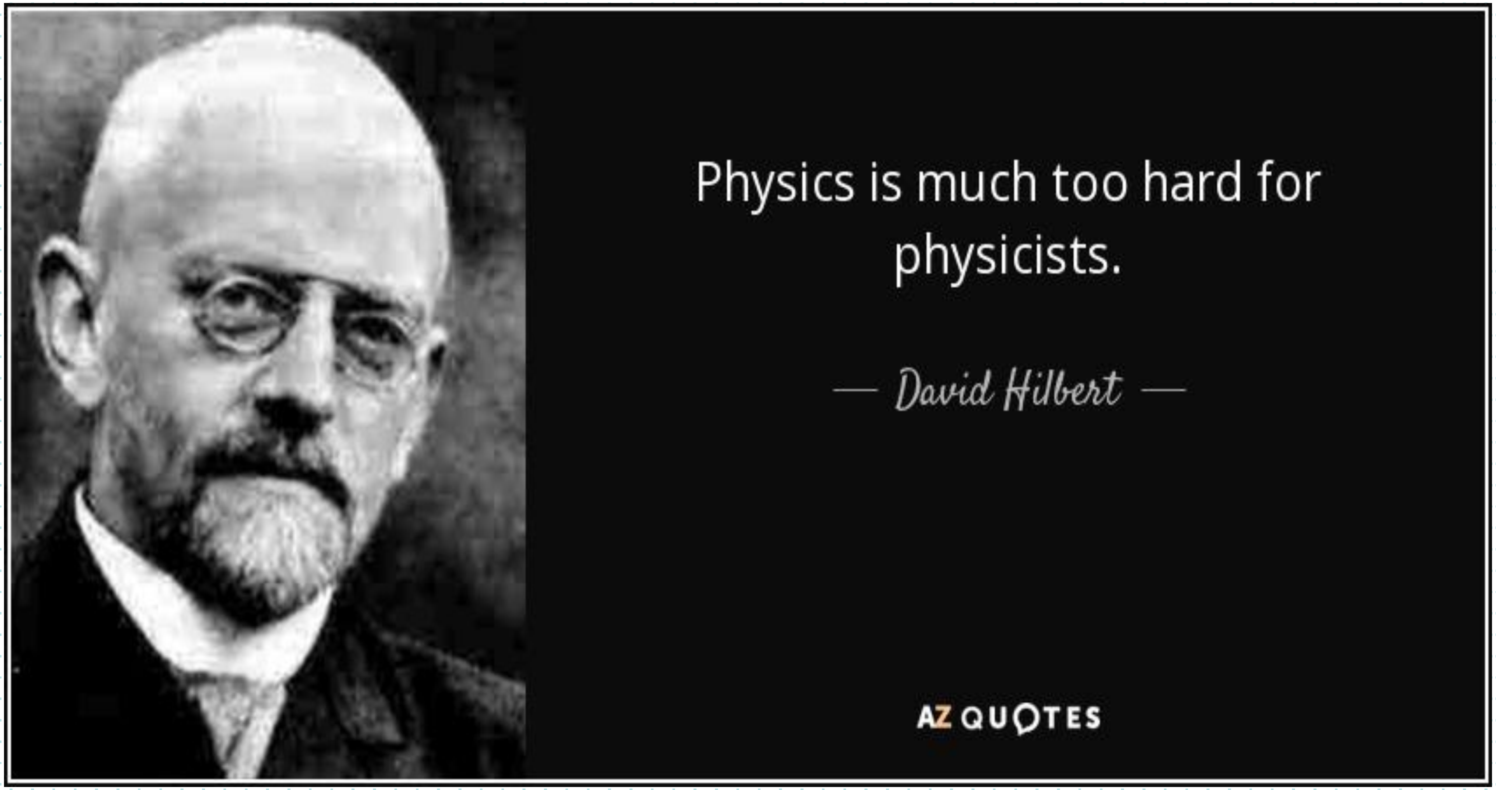



*Are you ready to agree?*
*In my view, unification of classical forces might be a very simple exercise for physicists would they replace the delta-operator with analytical densities of matter*

*My main undergraduate and graduate courses:*

1. *1st year - “Introductory Electromagnetism and Wave Motion” PHYS 1004, Carleton University, Ottawa*
2. *1st year - “Kinematics and Mechanics”, Algonquin College, Ottawa*
3. *2d year - “Electricity and Magnetism” PHY 2307, U of Ottawa*
4. *3d year – “Elements of Quantum Mechanics” PHYS 3701, Carleton University, Ottawa*
5. *4th year – “General Relativity” PHY 4346, U of Ottawa*
6. *4th year – “Nonlinear Electrodynamics”, MIPT, Moscow*
7. *5th year – “Microwave Plasma”, MIPT, Moscow*
8. *5th year – “Nonlinear Waves in the Ionosphere”, MIPT, Moscow*
9. *PhD – “Nanoengineering”, U of Ottawa,*
10. *PhD – “Advanced Magnetism and Superconductivity”, U of Ottawa*

*Field and matter in dual physics*

1. Contemporary physics textbooks still maintain the empty space paradigm (in question) due to observations and the suitable theory of classical fields.

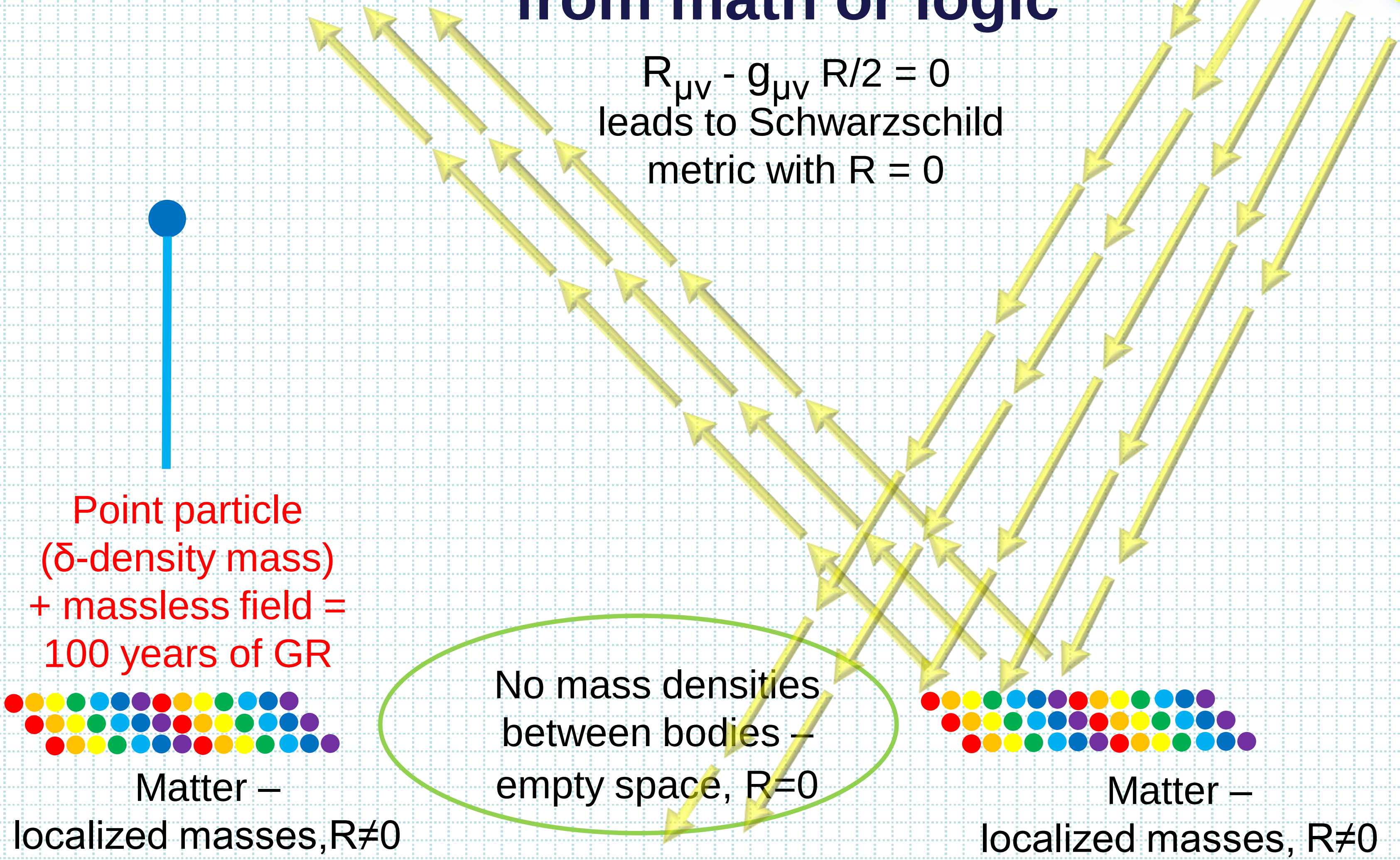
2. Empty space next to localized matter means dual physics where point particles (material peculiarities) and massless fields (around particles) are different entities.

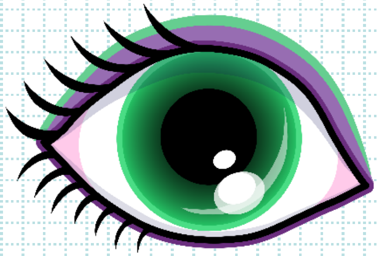
*What's wrong?*

3. Point charges result in the unphysical energy divergence of Coulomb fields.

4. Empty space for fields around localized sources in the Einstein Equation disagrees with the 1938-1939 pure field concept of Einstein, who since 1938-1939 had denied metric singularities (and black holes) for reality.

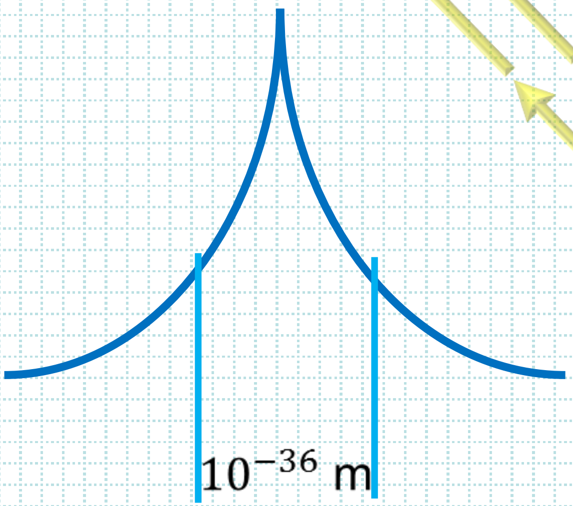
# Researchers postulated point matter (resulting in metric singularities) from daily observations, but not from math or logic



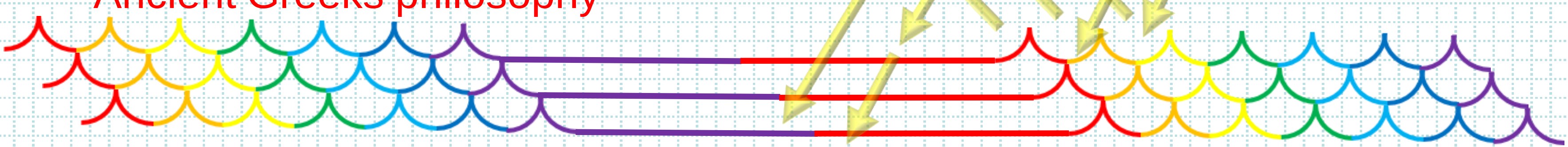


# Material space plenum in physical reality provides the same observations, but keeps metric solutions free from singularities

$R_{00} - g_{00}R/2 = 0$ under $R \neq 0$ leads to metric without singularities ! ! !




Radial material extensions beyond visual frames = 24 centuries of the Ancient Greeks philosophy



High mass densities:R≠0 Very low mass densities:R≠0 High mass densities:R≠0

In fact, the Ancient Greeks had unified space and matter before 322 BC.

Since 1929 Einstein had also realized that states of space itself are states of matter..

Drawing by Rea Irvin; © 1929, 1957 The New Yorker Magazine, Inc.

*"People slowly accustomed themselves to the idea that the physical states of space itself were the final physical reality."*

—Professor Albert Einstein

Plato (428 BCE – 347 BC) mentioned in Timaeus (Dialogues, 58d) that "there is the most translucent kind which is called by the name of aether (αíθηρ)".

Aristotle (384 – 322 BC) – planets and heavenly bodies consists on aether (quintessence) which also fills all celestial regions as a continuous material plenum (without empty areas).

Medieval scholastic philosophers (12th to 16th century) granted aether changes of density, in which the bodies of the planets were considered to be more dense than the medium which filled the rest of the Universe.

Newton (1642 – 1727) used the idea of ‘absurd’ aether to help match observations to mechanical rules of his physics.

Einstein (1879 - 1955) – “We could regard matter as the regions in space where the field is extremely strong”. From here, weak fields are material regions beyond visible frames of real (extended) bodies.

1915-1916 Einstein’s field+matter physics
*differs drastically from*
1938-1939 Einstein’s pure field physics which denies particles, singularities, and black holes

1938, A.Einstein and L. Infeld,

*The Evolution of Physics*, Cambridge Press

“We could regard matter as being made up of regions of space in which the field is extremely intense. . . . There would be no place in this new physics for both field and matter, for the field would be the only reality.”

“Classical physics introduced two substances: matter and energy. The first had weight, but the second was weightless. In classical physics we had two conservation laws: one for matter, the other for energy. We have already asked whether modern physics still holds this view of two substances and the two conservation laws. The answer is: ***No***. According to the theory of relativity, there is no essential distinction between mass and energy. Energy has mass and mass represents energy. Instead of two conservation laws we have only one, that of mass-energy.

This new view proved very successful and fruitful in the further development of physics. How is it that this fact of energy having mass and mass representing energy remained for so long obscured?

Is the weight of a piece of hot iron greater than that of a cold piece? The answer to this question is now ***Yes***, but on p. 43 it was ***No***..

We have two realities: matter and field. There is no doubt that we cannot at present imagine the whole of physics built upon the concept of matter as the physicists of the early nineteenth century did. For the moment we accept both the concepts. Can we think of matter and field as two distinct and different realities? Given a small particle of matter, we could picture in a naive way that there is a definite surface of the particle where it ceases to exist and its gravitational field appears. In our picture, the region in which the laws of field are valid is abruptly separated from the region in which matter is present. But what are the physical criterions distinguishing matter and field? Before we learned about the relativity theory we could have tried to answer this question in the following way: matter has mass, whereas field has not. Field represents energy, matter represents mass. But we already know that such an answer is insufficient in view of the further knowledge gained.

From the relativity theory we know that matter represents vast stores of energy and that energy represents matter. We cannot, in this way, distinguish qualitatively between matter and field, since the distinction between mass and energy is not a qualitative one. By far the greatest part of energy is concentrated in matter; but the field surrounding the particle also represents energy, though in an incomparably smaller quantity.

We could therefore say: Matter is where the concentration of energy is great, field where the concentration of energy is small. But if this is the case, then the difference between matter and field is a quantitative rather than a qualitative one.

There is no sense in regarding matter and field as two qualities quite different from each other. We cannot imagine a definite surface separating distinctly field and matter.

The same difficulty arises for the charge and its field. It seems impossible to give an obvious qualitative criterion for distinguishing between matter and field or charge and field.

Our structure laws, that is, Maxwell's laws and the gravitational laws, break down for very great concentrations of energy or, as we may say, where sources of the field, that is electric charges or matter, are present. But could we not slightly modify our equations so that they would be valid everywhere, even in regions where energy is enormously concentrated?

We cannot build physics on the basis of the matter concept alone. But the division into matter and field is, after the recognition of the equivalence of mass and energy, something artificial and not clearly defined. Could we not reject the concept of matter and build a pure field physics? What impresses our senses as matter is really a great concentration of energy into a comparatively small space.

We could regard matter as the regions in space where the field is extremely strong. In this way a new philosophical background could be created. Its final aim would be the explanation of all events in nature by structure laws valid always and everywhere. A thrown stone is, from this point of view, a changing field, where the states of greatest field intensity travel through space with the velocity of the stone. There would be no place, in our new physics, for both field and matter, field being the only reality. This new view is suggested by the great achievements of field physics, by our success in expressing the laws of electricity, magnetism, gravitation in the form of structure laws, and finally by the equivalence of mass and energy. Our ultimate problem would be to modify our field laws in such a way that they would not break down for regions in which the energy is enormously concentrated.”

# Possible approach to Einstein's quest toward pure field physics in Aristotle space plenum

**Global overlap of charged radial densities in the nonlocal Universe without empty space regions. Real masses and imaginary electric charges.**

RICCI SCALAR = SCALAR DENSITY OF CONTINUOUS MASSES

ZERO right hand side in the Einstein Equation for CONTINUOUS FIELDS of MASS-ENERGY

Newton force for imaginary charges corresponds to Coulomb

# My pro-Einstein but anti–Schwarzschild publications for nonempty space plenum in physical reality

1) Int. J. Theor. Phys. 47, 1261-1269 (2008), "Einstein's gravitation for Machian relativism of nonlocal energy-charges"
2) Jour. Supercond. and Novel Magn. 22, 627-629 (2009), "Relativistic quantization of Cooper pairs and nonlocal electrons in rotating superconductors"
3) Jour. Supercond. and Novel Magn. 22, 723-727 (2009), "Superfluid mass-energy densities of nonlocal particle and gravitational field"
4) J. Modern Physics, 3, N.10, 1465-1478 (2012), "Geometrization of Radial Particles in Nonempty Space Complies with Tests of General Relativity"
5) J. Chem. Chem., 7, 330-333 (2013), "From Steady 4D Quantization of Valence Electrons to Material Space Paradigm"
6) Bullet. Lebedev Phys. Inst. 41, 1-5 (2014), "Densities of Electron's Continuum in Gravitational and Electromagnetic Fields"

# Nonempty space physics

Static particle+filed densities: $2R^o_o - R = 0$ (no right hand side)

Radial solution: $Rc^2/4\pi G \equiv mn = mr_o/4\pi r^2(r+r_o)^2$

$$\rho_a(r)c^2 \equiv \rho_p(r)c^2 = E\frac{r_o}{4\pi r^2(r_o+r)^2} = \frac{c^4}{4\pi G r^2}\frac{1}{[1+(rc^2/GM)]^2}$$

$$r_o \equiv Gm/c^2$$

$$ds^2 = (1+r_o/r)^{-2}dt^2 - dr^2 - r^2 d\theta^2 - r^2 sin^2\theta d\phi^2$$

$$\sqrt{g_{oo}(r)} = r/(r+r_o)$$

Forces are exerted to probe energies, rather than to their scalar masses:

$$\mathbf{f} \equiv \frac{m_p}{\sqrt{1-v^2c^{-2}}}\nabla ln\left(\frac{1}{\sqrt{g_{oo}}}\right) = \frac{m_p\sqrt{g_{oo}}}{\sqrt{1-v^2c^{-2}}}\nabla\left(\frac{1}{\sqrt{g_{oo}}}\right) = -\frac{\hat{\mathbf{r}}GE_a}{c^4r^2}\mathcal{E}_p$$

Red shift may justify new metric without black holes:

empty space paradigm with

$$(d\tau - dt)/dt \equiv \sqrt{g_{oo}} - 1 \approx \varphi(1-\varphi/2c^2)/c^2$$

non-empty space paradigm with

$$\sqrt{g_{oo}} - 1 \approx \varphi(1+\varphi/2c^2)/c^2$$

# Gravitational attraction and repulsion

General equations of motion in the central static field, c=1

$$\begin{cases} g_{oo}dt/dp = 1, dp/ds = g_{oo}dt/ds = E_m/m = const \\ r^2 d\varphi/dp = J_\varphi = const, r^2 d\varphi/ds = J_\varphi E_m/m \equiv L = const \\ (dr/dp)^2 + (J_\varphi/r)^2 - g_{oo}^{-1} = const(= -m^2/E_m^2) \\ (dr/ds)^2 + (rd\varphi/ds)^2 - E_m^2/m^2 g_{oo} = -1, \end{cases}$$

Radial fall from infinity in **weak** and **strong** static fields

$$g_{oo} = 1/[1+(r_o/r)]^2$$

$$d\varphi/ds = 0,\ ds = \sqrt{g_{oo}}cdt\sqrt{1-v^2c^{-2}}, v^2 = (dr/\sqrt{g_{oo}}dt)^2$$

$$E_m/m = c^2\sqrt{g_{oo}}/\sqrt{1-v^2c^{-2}} = const \Rightarrow 1$$

$$dr/dt = \pm c\sqrt{g_{oo}(1-g_{oo})}$$

radial fall acceleration/deceleration: $d^2\mathbf{r}/dt^2 = -c^2 r_o \mathbf{r}(r^2 - 2r_o r - r_o^2)/(r+r_o)^5 \Rightarrow$

Newtonian attraction $-r_o c^2\mathbf{r}/r^3$ for $r >> r_o$ and GR repulsion $+\mathbf{r}c^2/r_o^2$ for $r << r_o$

# Post-Newtonian gravitational potential

$$W(\mathbf{x}) \equiv -c^2 ln \frac{1}{\sqrt{g_{oo}(\mathbf{x})}} = -c^2 ln \left(1 + \frac{r_1}{|\mathbf{x}-\mathbf{a}_1|} + \frac{r_2}{|\mathbf{x}-\mathbf{a}_2|} + ... + \frac{r_n}{|\mathbf{x}-\mathbf{a}_n|}\right)$$

$$r_i \equiv GE_i/c^4 = Gm_i/c^2$$

$$\mu_p(\mathbf{x}) \equiv \frac{[\nabla W(\mathbf{x})]^2}{4\pi G c^2} = \frac{\nabla^2 W(\mathbf{x})}{4\pi G} \equiv \mu_a(\mathbf{x})$$

$$\int d^3x \mu_p c^2 = \int d^3x \mu_a c^2 = E_{metric}$$

The Equivalence Principle of passive and active mass densities works analytically even for **many-body** systems

$$E_{metric} \equiv \frac{c^4}{4\pi G} \int d^3x \left( \frac{\frac{(\mathbf{x}-\mathbf{a}_1)r_1}{|\mathbf{x}-\mathbf{a}_1|^3} + \frac{(\mathbf{x}-\mathbf{a}_2)r_2}{|\mathbf{x}-\mathbf{a}_2|^3} + ... + \frac{(\mathbf{x}-\mathbf{a}_n)r_n}{|\mathbf{x}-\mathbf{a}_n|^3}}{1 + \frac{r_1}{|\mathbf{x}-\mathbf{a}_1|} + \frac{r_2}{|\mathbf{x}-\mathbf{a}_2|} + ... + \frac{r_n}{|\mathbf{x}-\mathbf{a}_n|}} \right)^2$$

$$= (m_1 + m_2 + ... + m_n)c^2 = const$$

Energy conservation for overlapping material spaces !!!

# From classical empty space to the world overlap of continuous elementary masses and continuous electrical charges

Int. J. Theor. Phys. 47, 1261 (2008)

$$\mu_p(r) \equiv \mu_a(r) = m\frac{r_o}{4\pi r^2(r_o + r)^2}$$

$$= \frac{c^2}{4\pi G r^2}\frac{1}{[1+(rc^2/Gm)]^2},$$

$$e \equiv \int_o^\infty 4\pi r^2 \rho(r) dr = -e_o$$

$$Gm_o/c^2 = 7 \times 10^{-58} m$$

$$\mathbf{E}^2/4\pi = (e/r_e)\nabla\mathbf{E} = (e/r_e)\rho(r)$$

$$\begin{cases} \mu(r) = Mr_o/4\pi r^2(r+r_o)^2 = \mathbf{w}^2/4\pi G c^2 \\ \mathbf{w}(r) = -\nabla W(r) = -GM\hat{\mathbf{r}}/r(r+r_o) \\ W(r) = -c^2 ln[(r+r_o)/r] \\ E_M = \int \mu c^2 d^3x \equiv r_o c^2/G = Mc^2. \end{cases}$$

$$\begin{cases} 4\pi\rho(r) = er_e/r^2(r+r_e)^2 = \nabla\mathbf{E}(r) = \mathbf{E}^2/(e/r_e) \\ \mathbf{E}(r) \equiv -\nabla W_e(r) = e\hat{\mathbf{r}}/r(r+r_e) \\ W_e(r) = (e/r_e) ln[(r+r_e)/r] \\ E_e = \int d^3x \rho W_e = \int d^3x \rho e/r_e = \int d^3x \mathbf{E}^2/4\pi = e^2/r_e \end{cases}$$

# Maxwell-Lorentz equations

$$\rho(r) = qn(r)$$

$$\begin{cases} div\ \vec{d}(x) = 4\pi\rho(x) \\ div\ \vec{b}(x) = 0 \\ c\ curl\ \vec{b}(x) = 4\pi\rho(x)\vec{v} + \partial_t\vec{d}(x) \\ c\ curl\ \vec{d}(x) = -\partial_t\vec{b}(x), \end{cases}$$

# Energy nature of continuous electrons

Einstein Principle of Equivalence works for electricity

$$\rho(\vec{x},t) = \vec{d}^2(\vec{x},t)/4\pi\varphi_o$$

$$\begin{cases} \rho(r) = qr_o/4\pi r^2(r+r_o)^2 = \nabla\mathbf{d}(r)/4\pi, \\ \mathbf{d}(r) = q\hat{\mathbf{r}}/r(r+r_o) = -\nabla\varphi(r), \\ \varphi(r) = (q/r_o)ln[(r+r_o)/r], \\ \int dV\,\mathbf{d}^2/8\pi = \int dV\,\rho\varphi/2 = (q/2r_o)\int dV\,\rho = q^2/2r_o \end{cases}$$

The local equality of the charge self-energy density, $\rho\varphi_o$, and the Coulomb field energy density, $\vec{d}^2/4\pi$, suggests finite electrostatic self-energy integrals for continuous particle charge, $E_p$, and for Coulomb field energy, $E_f$, both associated to the same elementary carrier of electricity,

$$E_p \equiv \varphi_o \int \rho(\vec{x},t)dv \equiv \varphi_o q = \frac{q^2}{r_o} \equiv \int \frac{\vec{d}^2(\vec{x},t)}{4\pi} dv \equiv E_f$$

Einstein Principle of Equivalence works for electricity

$$\int \rho(\mathbf{x},t)dv \equiv q = -ie_o$$ charge of the electron

$$\varphi_o \equiv E_q/q = q/r_o = c^2/\sqrt{G} = 3.48 \times 10^{27} StatV = 1.04 \times 10^{27} V$$

# Complex energy of the radial electron

rids the elementary charge of the Coulomb energy divergence

$$E = (\sqrt{G}m + q)\varphi_o$$

$$= mc^2 + ieG^{-1/2}c^2$$

$$= (0.511 - i \cdot 1.04) \times 10^{21} MeV$$

and the unphysical radiation self-acceleration
due to the ineverse direction of self-forces for imaginary charges

$$\mathbf{f} \equiv \frac{2q^2}{3c^3}\ddot{\mathbf{v}} = \frac{2(-ie_o)^2}{3c^3}\ddot{\mathbf{v}} = -\frac{2e_o^2}{3c^3}\ddot{\mathbf{v}}$$

# Imaginary self-energy flows instead of Maxwell-Lorentz equations

Field equations for imaginary elementary densities

$\rho(\vec{x},t) = ien(\vec{x},t)$, $\varphi_o = c^2/\sqrt{G} = 1,04 \times 10^{27} V$

$$\begin{cases} div\ \vec{d}(\vec{x},t)\varphi_o = -4\pi i \varphi_o en(\vec{x},t) \\ div\ \vec{b}(\vec{x},t)\varphi_o = 0 \\ c\ curl\ \vec{b}(\vec{x},t)\varphi_o = -4\pi i \varphi_o en(\vec{x},t)\vec{v} + \partial_t \vec{d}(\vec{x},t)\varphi_o \\ c\ curl\ \vec{d}(\vec{x},t)\varphi_o = -\partial_t \vec{b}(\vec{x},t)\varphi_o \end{cases}$$

# Complex energy flows as material field equations

Field equations for complex elementary densities

$$\rho(\vec{x},t) = (\sqrt{G}m + ie)n(\vec{x},t),\ \varphi_o = c^2/\sqrt{G} = 1,04 \times 10^{27} V$$

$$\begin{cases} div\ \vec{D}(\vec{x},t)\varphi_o = -4\pi\varphi_o(\sqrt{G}m + ie)n(\vec{x},t) \\ div\ \vec{B}(\vec{x},t)\varphi_o = 0 \\ c\ curl\ \vec{B}(\vec{x},t)\varphi_o = -4\pi\varphi_o(\sqrt{G}m + ie)n(\vec{x},t)\vec{v} + \partial_t\vec{D}(\vec{x},t)\varphi_o \\ c\ curl\ \vec{D}(\vec{x},t)\varphi_o = -\partial_t\vec{B}(\vec{x},t)\varphi_o \end{cases}$$

# Post–Coulomb logarithmic potential

$$d(r) = -\partial_r W(r) \qquad W(r) = -\frac{q}{r_o} ln\left(1+\frac{r_o}{r}\right) \equiv -\varphi_o ln\left(1+\frac{q}{\varphi_o r}\right)$$

$$\text{Newtonian sign } (-q/r_0)ln[(r+r_0)/r] \approx (-q/r) \qquad \nabla^2 W = 4\pi\rho \Rightarrow \varphi_0^{-1}(\nabla W)^2$$

real Coulomb forces of imaginary charges

$$q_1[-\nabla(-q_2 r_o^{-1})ln(1+r_0 r^{-1})] = ie_1(-ie_2)\hat{\mathbf{r}}/r(r+r_0) \approx e_1 e_2 \hat{\mathbf{r}}/r^2$$

$$\frac{\partial_r[r^2\partial_r W(r)]}{4\pi r^2} = \frac{[\partial_r W(r)]^2}{4\pi\varphi_o} = \frac{q r_o}{4\pi r^2(r+r_o)^2} = \rho(r)$$

$$n(r) = r_0/4\pi r^2(r+r_0)^2 \qquad r_0 = r_m + i r_q$$

## Joint Newton - Coulomb Interaction Law

$$F = -Re\frac{(m_1\sqrt{G}+ie_1)(m_2\sqrt{G}+ie_2)\hat{\mathbf{r}}}{r^2} = \frac{(e_1 e_2 - G m_1 m_2)\hat{\mathbf{r}}}{r^2}$$

## *Unification of real gravitational, $m\sqrt{G}$, and imaginary electric, $ie$, charges*

$$\vec{D}(r) = -Q\hat{\mathbf{r}}/r(r+r_0) \qquad Q \equiv \sqrt{G}m + ie$$

$$\rho(r) = Qr_0/4\pi r^2(r+r_0)^2 \qquad r_0 = \frac{Q}{\varphi_0} = \frac{mG + ie\sqrt{G}}{c^2}$$

## Sommerfeld constant as ratio of classical and quantum constants

$$|r_0| \approx e_0\sqrt{G}/c^2 = 1,38 \times 10^{-34} cm$$

$$l_p \equiv \sqrt{\hbar c}(\sqrt{G}/c^2) = 1,62 \times 10^{-33} cm$$

$$|r_0|^2/l_p^2 \equiv \alpha \approx 1/137$$

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# PURE FIELD ELECTRODYNAMICS OF CONTINUOUS COMPLEX CHARGES

MOSCOW
MIPT
2015

Tutorial for the 4th year course
“Nonlinear Electrodynamics”

MIPT and many other top universities enroll graduate students in courses taught at the leading laboratories where the cutting edge science of currently unresolved problems is explored. Suggested learning through brainstorming of continuous charges instead of customary localized carriers of mass and electricity can open a new vision of the nonlocal material world, which is invisible to superficial human perception. Well-established Euclidean electrodynamics and Sommerfeld relativistic quantization together require us to turn our attention back to the nonempty space plenum of the Ancient Greeks. Modern researchers should reject the conventional paradigm of curved empty space, which does not exist in physical reality. Contemporary empty space physics is overloaded with controversial energy problems, sophisticated metric constructions and unphysical singularities. By accustoming nonempty space and continuous charges under this tutorial (which tends to resolve radiation self-acceleration, Coulomb energy divergence and many other failures of Classical Electrodynamics), a reader on his own may renew the Einstein mass-energy formula by electric terms, may relate the physical meaning of the Ricci scalar of material metric space to its scalar mass density, etc. Nonempty space Euclidean electrodynamics is a prerequisite to new interpretations in General Relativity and to a better reading of the Einstein Equation, where conventional point masses at the Equation right-hand side should be moved to the pure field (left-hand) side as continuous Ricci curvatures.

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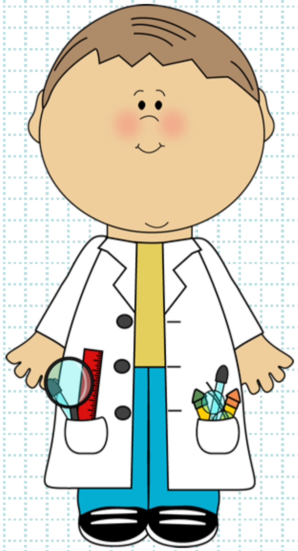
# Drop inflicted delta-densities – return to analytical mathematics and Aristotle nonempty space-plenum for better physics!


## THANK YOU



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