Why Gravity Cannot be a Classical Force

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Abstract

Some properties of general fields are reviewed. Electrostatics is a natural, universal paradigm, part of classical field theory. Newton's Gravity Theory, on the other hand, has properties that suggest a quantum origin, via an internal property akin to spin. Such an abstract "internal" property breaks isotropy of pointwise singularities of fields, yielding an attractive force.

Theory of Gravity based on the quark structure is consistent with the above considerations.

1 Introduction

Many scientists tried to unify electrostatics and gravity. The major stumbling block is that Gravity is only attractive. This implies that only one type of charge is needed and the *universal law of interaction* we call Coulomb's Law has to be adapted by reversing the sign: alike charges attract!

These properties are not "natural", from a physical point of view, when formulated within the mathematical paradigm of the theory of fields. Einstein solved this problem by modeling gravity as geometry, lines of force field with geodesics (not oriented). He used deformations (of metric) to break local isotropy. QFT went further postulating the what the interaction strength is, via propagator as fundamental concept, instead of distance (metric); but in hindsight, "macrscopic" Gravity is just a residual, average force of quark field interactions (Hierarchy Problem), which breaks local isotropy via quark structure of nucleons, which can be modeled effectively via spin.

The article *argues* why Gravity is not a classical field, focusing on its always attractive property: this suggests that it does not come from a classical scalar potential, but rather seams to originate from a minimization of discrete and energy levels ("quantum"), not associated just to distance (Newton's Law for Gravity). It is neither just geometry (associated to perturbation of the metric), because GR is an incomplete theory: Gravity can be locally controlled with low energy methods via spin orientation methods [4], not to mention the need for corrections imposed by Cosmological arguments (dark matter and dark energy [22]).

Thus we attempt to add another conceptual layer of understanding of Gravity, namely that it is not natural to model it as a classical force, nor as geometry[1]; it was explained in previous articles (see [25]) as being of a quantum origin, based on *observation, experiment and accepted theory* (Standard Model of Elementary Particle Physics; see footnote p.6).

1.1 Classical field theory and Newton's Law

We will show that classical field theory is conceptually incompatible with Newton's Law of Gravity, at the level of its foundations: superposition principle and oriented, integral lines of field together with *pointwise* sources of field, which mandates $SO(3)$ invariance (points without "internal structure").

Briefly, a "matter field" has charges as sources or sinks of lines of force that originate or end on them; also away from singularities modeling charges with mass, lines of force are oriented. Gravity modeled using fields, in contrast, require a "total charge" of opposite type at infinity, and has singularities at non-material points (Lagrangian points). Moreover, the attraction between two masses, as gravitational charges, is not justified by the field model (orientation of lines of force becomes relative), and requires a change of sign introduced "by hand", depending on what is considered "source" and what is considered "probe".

[1]... although this is a huge progress, with "permanent" benefits in Astronomy and Cosmology.

1.2 General fields and Break of Symmetry

A way to go beyond Coulomb charges, sources of rotational symmetric fields (individual charges), requires break of symmetry.

Einstein's GR achieved this via deformation for the metric, but outside of the theory of fields (Geometry).

More general fields that break rotational invariance for their singularities (sources of field) have to have an "internal" property that justifies this; or another way to put it, we can model the break of symmetry as due to an "internal" (not geometrically external) property which we can call it spin, analog to the abstract property in QM, observable in Stern-Gerlach experiment.

1.3 Break of isotropy and Spin dependence

We then show how such a spin dependent law (quantum / discrete energy levels) explains the "weird" rules of signs in Newton's Law: it is a discrete version of minimization of energy principle, different from Hamilton's minimal action principle. The later yields Coulomb Law, under isotropy assumption of the field of a pointwise charge, while the first yields Newton's Law, with its "adapted" rule of sign for the force.

1.4 Origin of spin and Quark Field

Finally, we look at the internal structure of nucleons for the origin of such "abstract property": quark structure! We argue that proton and neutron's spin can be derived from the quark structure. In this way we connect with the previous articles of the author explaining how quark structure yields Gravity as a perturbation of EM; and of course, these are all part of the quark field [3], as seen in the accounts of the Nuclear Force, SM; then note that the main reason for color QCD is to keep quarks confined (the NF is a resultant of meson exchange, from Yukawa to the present theories).

2 Generalities on classical fields

2.1 Fields and Dynamics

A break of symmetry of the theory in general comes by separating sources of fields (Field Theory) from probes evolving in such fields: their dynamics; it allows to linearize the problem, avoiding complications (propagation of interactions etc.).

The probe is considered too small to affect the field significantly, so we just look at the dynamics of such a probe in a given field.

We can also solve the electrostatics problem first (what is the field for a given set of charges) and then solve the dynamics problem, e.g. $ma = F_{field}$ etc.

2.2 Fields and Charges

Divergence detects scaling transformations. Singularities can be sources or sinks, positive or negative charges. The corresponding lines of force start or end there. Lines of force are open. Having lines going to "infinity" is not physical, in some sense. The natural case is when lines start at a source and end at a sink, having positive and negative Coulomb charges (or more general types of singularities).

Curl detects infinitesimal rotations. Singularities in 3D are Dirac lines. The lines of force are closed, as in magnetism.

2.3 Coulomb's Law

Electrostatics is the paradigm of classical, physical fields: central and conservative (Maxwell's equations: EM paradigm).

Coulomb's Law is the general form of a force due to a field satisfying superposition, central and conservative, with pointwise charges. Assuming charges are pointwise implies rotational symmetry (no "hidden" structure).

Then “conservative” implies harmonic potentials, hence Laplace / Poisson equation, with $1/r$ fundamental solution, automatically rotational symmetric in Euclidean metric (perturbing could be a route to G-field, of course: General Relativity, before propagators were invented in QFT, but unfortunately as a non linear theory).

The general such types of singularities: positive charges (all lines of field out), or negative (all in).

Now “finiteness” implies lines out from a source (positive charge) must end in a sink (negative charge). Now this *forces* the rules of signs-Force: opposite charges attract, same sign charges repel.

This universal law is Coulomb’s Law: $F_{field} = k_C q_1 q_2 / r^2$, with direction corresponding to the above rule of sign-force (and central: no radiation / relativistic / interaction corrections).

And we have electrostatics; with Newton’s Mechanics (general DE framework, without friction etc.) we get the dynamics.

The relativistic (conformal) version is Maxwell-Faraday Theory. This is another story ...

2.4 Newton’s Law of Universal Gravitation

Now why is Newton’s Gravity only attractive? is it compatible with the above?

The claim is no: even if we would have only one type of charges (convention: lines of field in: “free falling”), lines of field would be infinite (not physical; see Zeno, Aristotle etc.), unless emerging from immaterial, mathematical singularities (Lagrangian points) and clearly exhibiting the source-probe break of conceptual symmetry of the theory (“fall in Gravitational field”[2]).

If we want to claim *only attraction* we have to put a negative sign in the force formula, “by hand”. Two charges would not be connected by oriented lines of field, as in electrostatics, and non-material singularities of the field will be involved (Lagrangian points).

... and why all other lines of field end at infinity, as if it’s a compensating virtual image of opposite sign?

This is in many respects not a natural scenario: we have superposition of fields, sources, probes, conservative, central, but lines of force are rather geometric, infinite (not ending anywhere), not physical [3]

With the extra negative sign in the force, limiting to only + charges [4], Coulomb’s Law becomes Newton’s Law of Gravity, with a different constant, very very small, much too small: Why? (Hierarchy Problem: [6]). Indeed, the rest ($1/r$ from conservation and central force assumption, superposition / additive force (resultant) yields $m_1 \cdot m_2$) remains the same as in Coulomb’s Law.

In hindsight, all these “issues” are related: Newton’s Gravity is an emergent force, resulting from a statistics average of a force of quantum origin, under minimization of discrete energy levels. These were attributed to spin-spin interaction of nucleons in a long range interaction, as a “shadow” of the perturbation of electrostatic force component via break of symmetry mandated by their quark structure.

But we will remain at a classical level, involving fields, with only one “unseen” degree of freedom (“quantum”) aspect, we will call spin.

3 Breaking the “symmetry of the point”

When matter charges are pointwise singularities of the field, one usually assumes rotational symmetry (no reason to have privileged directions). Then charges can be positive or negative, assuming a naturalness hypothesis, as explained in the introduction (finite and oriented lines of field, not to have immaterial singularities).

To account for Gravity as a “natural” field theory, one may look at more general types of fields, which break $SO(3)$ symmetry. Historically, there are three way to implement this: 1) deformation of the metric, so that the local isometry group is not $SO(3)$, e.g. General Relativity; 2) Introducing spin, e.g. Quantum Mechanics; 3) Introducing quarks (fractional charges, $U(1)$ or $SU(3)$ (color), which could also explain (in principle, for now) where the spin of the baryons comes from.

[2] The two body problem can be solved, though, in the center of mass coordinate system.

[3] Compare with Faraday’s intuition and Maxwell’s vector potential, as an essential ingredient of EM; makes EM a gauge theory, in fact a quantum theory: Aharonov-Bohm etc. So even EM is a quantum theory, not just relativistic (conformal aspect).

[4] ... positive to match inertial mass, initially, but then adopted in Einstein’s GR as the Equivalence Principle.

3.1 General Relativity

Briefly, GR deforms the metric, which implies deforming the Laplacian, and hence the fundamental solution: $1/r$. But why matter would affect the distance, really? (beyond postulating Einstein's equation; or heavy objects on a membrane picture). The distance is in fact a measure of the intensity of interaction per unit of mass (individual particle); QFT went further, taking this as fundamental, defining "distance": the propagator.

3.2 Introducing "Spin"

Spin, as an abstract property of a point particle, is an effective way to break isotropy, using two values "up/down". Now if an interaction depends on spin also, not just distance, it will yield an attractive "force", under minimization of energy (see bellow).

3.3 Quarks

The quark structure of a baryon implies the total field (electric and strong, for now, depending on the type of probe used to interact with), will not have $SO(3)$ symmetry; e.g. the neutron has two sinks where lines of field go in and one out, of double intensity, in three principal directions we claim are represented by the quarks.

This model allows to derive the abstract property of spin, not as an analog of angular momentum due to rotation, but rather reflecting the existence of discrete energy levels (requires 3rd quantization: finite Platonic subgroups of $SU(2)$, the double cover of $SO(3)$).

4 Two variational principles: continuum vs. discrete

The freedom of choosing the form of the potential energy shows that the Lagrangian or Hamiltonian formalisms are a universal framework for mechanics, capable of accommodating Newton's Gravity too.

4.1 Hamilton's Principle

Newton's Mechanics can be derived from Hamilton's minimal energy principle or Lagrangian formalism, via variational principle.

This Minimum Principle can yield attractive and repellent forces between two charges, depending on the orientation of the lines of field.

Gravity is of a different kind: an isolated point charge has an isotrope field; two pointwise masses define a field with "unoriented" lines of force, unless we break the line of force at the Lagrangean point, where the probe is in equilibrium. Such a singularity of the field is "un-natural", from a physical point of view.

4.2 Discrete Levels of Energy

If we have a set of discrete energy levels per point, minimizing this discrete internal energy will *always yield an attractive force* (internal state transitions, not external/metric mechanism).

Consider two particles and spin 1/2, hence four energy levels under spin-spin interaction. The particles will "rotate" ("Brownian mortion"/fluctuations) to minimize mutual energy, hence yielding an attraction.

This suggests that the properties of Gravity, being attractive in the first place, may be due to such a minimization, not position depending potential (which again, can be done, but involves some choices and non-physical singularities of the field, all other lines of force are infinite, not connecting bodies as sources of the field etc.).

5 Gravity from spin dependence

Thus we claim that because Newton Gravity is always attractive, and lines of field are not oriented (unless establishing a convention: falling elevator, involving non-physical Lagrangian points with opposite orientation for a pair of points etc.); it is not a physically natural classical field theory.

Breaking the local symmetry may justify why it is always attractive.

5.1 Gravity in GR is Always Attractive

GR broke symmetry and modeled it via deformation of metric, resulting in a geometric theory of Gravity, only attractive. Lines of force were replaced by geodesics (not oriented) etc.

But experiment shows that Gravitational Interaction can be locally controlled, via orienting the spin direction [4] (experiment), and can even be reversed (controversial topic, of course). In other words, the equivalent gravitational charge can be modified, e.g. weight of a body at the surface of the Earth can be reduced.

5.2 Spin origin of Newtonian Gravitational Attraction

As explained above, energy levels due to spin yield an attractive force. Such an intrinsic property allows to "hide" its origin, the quark structure of nucleons.

That Gravity can be controlled via Dynamic Nuclear Polarization, and is not always attractive[5], shows Newton and Einstein Theories are incomplete.

This property is also expected from the quark structure of nucleons [4] (see also presentations). Indeed, the theory of Nuclear Force contains the terms which already suggest Gravity is part of the SM; in order to do that, the potentials involved need re-evaluated [3].

This also allows to fit Gravity within the general paradigm of field theory (quark field), at a classical level (no quantization), using just $SO(3)$ break of symmetry.

Then macro-Gravity is the result of summing over spin directions of nucleons. Due to an almost random distribution, the resultant is much weaker then the G-force for one pair of particles, and always attractive near a body (away from Lagrangian points). This also explains the Hierarchy Problem (one side of it) [6].

5.3 Quantum General Relativity

5.3.1 Classical (Effective) ...

One may include in GR the procession of spin directions (nucleons like tiny gyros) and the spin-spin interaction that yields Gravity by including a "brownian"/quantum fluctuation of the macroscopic metric of GR, with a local periodic term via the tangent (spin) bundle, yet with statistic random orientation of the procession axis (spin).

There are some Modified Gravity Theories having a spin component included. This should be correlated to the quark field / quark model and Theory of Gravity of quantum origin.

5.3.2 ... and Quantum

The idea is that each particle carries a clock (Einstein) that corresponds to the quantum phase (Feynman) $e^{i\omega t}$ and connects with the above and Hopf fibration $U(1) \to SU(2)$ as the building block of the Quantum Network [7]. Then, we can think of this model in connection with time crystals: "gyro-clocks"). Discrete Platonic symmetries (quark flavors) will justify the magnetic moment $m = -l..l$, associated to spin.

The electric, long range inter-quark interaction ($U(1)$), reflected in the spin dependence of nuclear force, yields gravity, under averaging over directions.

5.3.3 Quantum Gravity

The usual meaning of QG is explained in [24]. The main direction of "quantizing" Space-Time itself, and not matter, is inadequate from various points of view: ambient Space-Time does not exists in itself: GR is based on manifolds anyways; this does not take into account quantization of matter (Particle Physics); maintains the concept of point etc.

We also understood that the correct way to quantize distance, as a common measure of strength of interactions, is via propagators (QFT).

Moreover GR and QG, both disregard Lab experimental data.

[5] This means a body can respond in a gravitational field as if having a "negative charge".

6 Conclusions

In this article EM is considered as the universal paradigm of classical field theory: Electrostatics, as a paradigm of isotropic field sources modeling material singularities and Maxwell's dynamics of fields (conformal, not just relativistic).

The characteristics of a physically meaningful classical field, ignoring radiation / interactions, were considered to be: central force, conservative, finite lines of force, oriented, emerging and ending on singularities called charges at finite distance[6]. Then Coulomb's Law is the unique mathematical solution (fundamental solution of Poisson equation); charges are positive or negative (a source has a sink, for "equal" positive matter and "negative matter"[7] and the rule of signs for charges holds: opposite charges attract, consistent with orientation of lines of force and Complex Analysis (conformal transformations: Mobius transformations $Aut(\hat{C})$[8] correspond to (projective) Lorentz transformations PSL_2, laminar "flow": equipotential - streamlines interpretation). In contrast, Newton's Gravity does not fit well in this paradigm: lines of force end at infinity, or at immaterial points (Lagrangian points), with conventional orientation that does not reflects how two charges (masses) interact, but rather how a "probe" behaves (dynamics)[9]. The force is always attractive "by hand", not resulting from geometry of the flow of the lines of fields.

This was vindicated by Einstein's Theory of GR which modeled Gravity as geometry, not as a force field. Unfortunately, GR has limitations when confronted with Cosmological data [22].

Moreover various recent experiments (Alzofone, Podkletnov, Ning Li etc [9] and references within, e.g. [14, 16, 10, 15, 12, 13, 21, 20]) show that behavior of bodies in G-field can be controlled at low energies (microwaves DNO / rotation in a magnetic field, in superconductive regime), which is inconsistent with the geometric, essentially attractive gravity, of Einstein's GR, and supporting the EM / Coulomb Law paradigm, but of a quantum structure origin.

Then it was argued that one can obtain a more natural, physically meaningful, classical field theory model of Gravity, if local isotropy of Coulomb charges is broken, e.g. using the concept of spin as an abstract quantity and a correction spin-spin interaction term. Then, for electrically neutral bodies (zero force without the spin-spin term), a different minimization procedure, of some discrete energy levels, would yield an always attractive force; together with an almost random distribution of spin directions (satisfying Boltzmann's Law for the partition function), when averaging the resulting contributions, would yield a very weak force, solving the Hierarchy Problem [6].

Moreover experiments show that Gravity can be controlled precisely via Dynamic Nuclear Orientation, i.e. of the spin directions of nucleons, and thus confirming the above heuristic arguments (naturality, physically meaningful singularities, finiteness).

The author considers that these arguments are pointing towards a quantum origin of the Gravitational force.

In hindsight, previous work and articles have just established this: from observation and experiment, to theory, which uses well established mainstream science: the quark model of the Standard Model of Particle Physics[10].

The need to understand quantitatively how the effective potential of the Nuclear Force already contains and suggests Gravity is a side effect of quark structure and Electroweak interaction, still remains to be addressed by specialists. A preliminary program of "needed" unifications will be proposed [23].

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[6]... or closed for magnetic charges, but this involves the vector potential, with quantum / relativistic aspects ...

[7]... in contracts with the unreasonable demand for equal matter and anti-matter ...

[8]... remains to understand the relation to quark / Hopf model and ST pair of pants / trinion ...

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