Gravity-Matter Duality

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Abstract

Gravity-matter duality is suggested as the first step toward quantum gravity, ensuing from the idea that the phenomenon dubbed 'gravitational field' is a new form of reality, known as *Res potentia* — "just in the middle between possibility and reality" (Heisenberg, Slide 7). The essential similarities and differences between gravity-matter duality and wave-particle duality are briefly examined, with emphasis on the proposed joint solution to *exact* localizations of gravity and "quantum waves" at spacetime points. The latter are endowed with brand new structure and topology due to the fundamental *flow of events* suggested by Heraclitus and Plato.

1. Introduction

Perhaps the best way to launch a new interpretation of gravity is to compare it to the one it seeks to replace. Here I will briefly outline the metaphysical ideas in Einstein's General Relativity (GR) — "Spacetime tells matter how to move; matter tells spacetime how to curve", John Wheeler — leading to the "coupling" of gravity to matter (Fig. 1) and to the hypothesis that gravity were some "fictitious force", as stated in current GR textbooks.

Which goes first, gravity (Fig. 1.1) or matter (Fig. 1.2)? Is their mutual determination instantaneous, resembling EPR correlations? If it is not instantaneous, how is the *next* gravity-matter negotiation going to be accomplished, in order to produce gravitational radiation 'in time', as read with a clock? How was the *previous* gravity-matter negotiation fixed, in order to have the two consecutive negotiations "separated" by an infinitesimal temporal difference **dt** ? If gravity is not a *bona fide* 'force', how could 'the grin of the Cheshire cat *without* the cat' (Fig. 1.1) *interact* dynamically, once-at-a-time **dt** , with the 'cat' (Fig. 1.2) placed in the right-hand side of Einstein's field equations?

Fig. 1.1   Fig. 1.2

I don't think there is consensus on these open questions in GR, so let me start *ab ovo*.

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2. Gravity-Matter Duality

Let me stress that GR is still a work in progress — Einstein was searching for "a total field of as yet unknown structure" (p. 6 in holon.pdf) until his last days. To explain Einstein's 'total field' (*Gesamtfeld*), it is instructive to point out what his *Gesamtfeld* is <u>not</u>.

Suppose you order a pizza, which is delivered at your doorstep, and then you bring it in your kitchen, as a contribution to your lunch. The pizza you have in your kitchen and the pizza you ordered previously are identical, so if you think of gravity as a pizza, you must conclude that the contribution of gravity to your lunch (placed in the right-hand side of Einstein's field equations, see Fig. 1.2) is *exactly* the same 'pizza' that was delivered at your doorstep earlier. If true, gravity (Fig. 1.1) will be a *bona fide* physical field, and the conservation of mass-energy of the system 'the pizza shop & your house' will not be violated. It is like withdrawing cash from ATM (p. 3 in CEN.pdf). It may look simple and "intuitively clear", only there is a problem: this is not the case chosen by Mother Nature.

We propose 'gravity-matter duality', based on the ontological distinction between all physical stuff, denoted with 'matter' (Fig. 1.2), and its *unphysical* gravitational "field" (Fig. 1.1), which we call 'gravity'. Unlike gravity (ref. [19] in spacetime.pdf), matter can possess stress-energy-momentum and angular momentum, and has the ontological status of 'objective reality *out there*' (e.g., the pizza above): at every instant 'here and now', it either '*is*' there or '*is not*' there (p. 25 in spacetime.pdf). No third option is available in classical physics. Gravity, on the other hand, nether '*is*' nor '*is not*'. It is *Res potentia* — "just in the middle between possibility and reality" (Werner Heisenberg, Slide **7**). Thus, gravity and quantum "waves" are neither *physically* real "pizza" nor some "fictitious force" viz. "state of knowledge".

Recall also that in wave-particle duality, which is the cornerstone of Quantum Mechanics (QM), there is no explanation of the *source* of "quantum waves" endowed with *complex* phase (Chen Ning Yang, ref. [36] in spacetime.pdf). Here we do not offer any hypothesis on the *source* of gravity either. Instead, we postulate **dual** existence of two *complementary* aspects of the world, in line with the doctrine of *trialism* (Slide **14**).

As an illustration of gravity-matter duality, see Fig. 2 (Fig. 23, p. 25 in spacetime.pdf).

Fig. 2

The physical stuff dubbed 'matter' (Fig. 1.2) is like colorful nail varnish: we are 'chained Eskimos' (Fig. 4 in CEN.pdf and Slide **14**), and can never see some **intact** *colorless* bare nails (Fig. 2), because they have *exactly* **zero** **chance** to be explicated as *physicalized* (colorized) reality. Surely we could not paint a picture (Fig. 1.2) without its *bare* colorless

"canvas" (Fig. 1.1), yet the two are ontologically different and *complementary* forms of reality, as we know since Plato.

An important difference between the two forms of duality is that the gravitational analog of quantum entanglement (Fig. 11 and p. 11 in CEN.pdf) is observable from the length scale of galaxies (holon.pdf). Crudely speaking, the gravitational entanglement resembles the holomovement of a school of fish (ref. [11] in hi_numbers.pdf and pp. 89-90 in gravity.pdf). It is not present in gravitating systems of the size of the Solar System for which we can apply the *linearized* approximation of GR, at the expense of presenting gravity as "a powerless shadow" (Hermann Weyl, ref. [3] in gwa_rip.pdf). With the exception of gravitational radiation, such 'spherical cow' approximation of gravity is FAPP acceptable up to the Solar System, just like we ignore all quantum-wave effects in Newtonian mechanics. Keep in mind that the diameter of our Solar System is roughly 10^{13} times smaller than the observable universe, so it should not be surprising that many "dark" effects of gravity, including gravitational radiation (Sec. 3), require brand new theory of quantum gravity for their explanation (p. 5 in holon.pdf), and gravity-matter duality is the first step in this direction.

Let me briefly examine the localization of gravity, as perpetually changing colorful 'nail varnish' (Fig. 2). I trust the reader could easily compare it with the localization of quantum "waves" (Slide 7), as in both cases the *colorless* **intact** quantum-gravitational *Res potentia* is not directly observable.

3. Gravitational Radiation

We can never observe the *intangible* energy of gravity (Hermann Bondi), just as we can never observe *Res potentia* (Werner Heisenberg, Slide 7). We can observe *gravitational radiation* only as perpetual energy-momentum **non**conservation (Hans Ohanian): matter is coupled to itself *via* gravity, and Einstein's *Gesamtfeld* (Sec. 2) cannot in principle be traced to any *tangible* form of energy in the right-hand side of Einstein's field equations (Fig. 1.2). Physically, Einstein's *Gesamtfeld* will be "dark", because *Res potentia* does not emit nor reflect light. In this sense, *Res potentia* is not *directly* observable: check out the explanation from John Polkinghorne on p. 12 and ref. [20] in CEN.pdf, Kuchař's perennials (p. 22), Rovelli's non-metric "time" (p. 84), and Unruh-Wald "nondynamical time". Were the global cosmic time *physically* observable, the "colorless nails" (Fig. 2) and the universal Unmoved Mover (Aristotle) will be *physically* exposed, and the theory of relativity will be demolished.

Which is why at every 4D point 'here and now' (see above), Einstein's *Gesamtfeld* is being **nullified** (akin to wave function "collapse"). It (not "He") has *already* completed its *atemporal* negotiation for the present 'here and now', leaving only one negotiated state — one-state-at-a-time (see above), without any *physical* "gaps" (Fig. 4, p. 6 in CEN.pdf). Thus, the perpetual localization of gravity renders the spacetime of 'the cat' (Fig. 1.2) a *perfect* continuum of everlasting **re**-created *physicalized* universes — one-at-a-time.

Which is why we can eliminate the *intangible* (Hermann Bondi) gravitational source 'by hand' (László Szabados), just like we "eliminate" the wave function. Forget about tensors. Why? Because tensor fields are mathematical objects applicable *only* in classical physics, which describes the physical world as 'objective reality *out there*' – it either '*is*' or 'is *not*', always with certainty (Erwin Schrödinger). In both cases of duality, quantum and gravitational, we face bona fide 'potential reality' or *Res potentia*, which neither '*is*' nor 'is *not*' (see above).

The crux of the matter is the point-wise *physicalization* (Fig. 3) of quantum-gravitational universe, which requires brand new structure and topology of what we call 'spacetime event'. The latter is the very *interface* (Sic!) between the potential future, inhabited by *Res potentia*, and the irreversible past made by accumulating 'facts' comprising the *physicalized* quantum-gravitational universes — one-universe-at-a-time.

This is the fundamental *flow of events* (dubbed 'biocausality' in January 1990), which must never be *physically* exposed, as explained in Sec. 3 above.

4. Structure and Topology of Spacetime Events

The structure of spacetime events 'here and now' was shown previously in Slide 13 and in Fig. 7, p. 8 in spacetime.pdf, reproduced below.
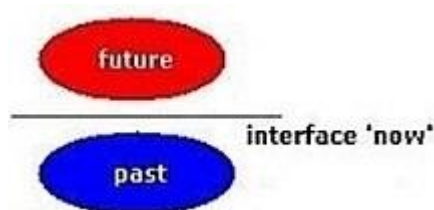

Fig. 3

Fig. 3 is obtained by rotating Fig. 1 above 90 degrees clockwise. The idea is very old — see the Dragon metaphor on p. 3 in Penrose_diagram.pdf. Thus, we have *perfect* localization of *Res potentia* and explanation of the two forms of duality, quantum and gravitational.

We need quantum cosmology to explain the *dynamics* of gravitational radiation, as stated above. The alleged 'block universe' is false. *Panta rei conditio sine qua non est* (CEN.pdf).

Needless to say, there are many outstanding mathematical challenges from the new model of spacetime (p. 6 in Penrose_diagram.pdf), dubbed Relative Scale (RS) spacetime (p. 5 in holon.pdf). By the end of 2018, I intend to post three brief video lectures at my YouTube channel, to explain the so-called hyperimaginary numbers (p. 9 in hi_numbers.pdf) and their implications to point-set topology, set theory, and number theory (p. 20 therein).

As to the experimental predictions of RS spacetime, such as modulating inertia (Kevin Brown) with REIM (p. 5 in holon.pdf), I strongly contest the murky assumption that the spacetime *manifold* might be asymptotically Minkowskian at each point (Fig. 3). As Kevin Brown acknowledged, Einstein's GR (Sec. 2) "does not in any way explain or obviate the principle of inertia" and "we must simply rely on an intuitively plausible choice, based on our pre-existing notions of the topological arrangement of events and our identification of persistent entities through time."

But how do we identify *persistent* entities (Fig. 2) through physically unobservable Heraclitean *flow of time*, which is being *exactly* **re-nullified** (Sec. 3) at every 4D event 'here and now'? Compare Fig. 4 and Fig. 9.2 in CEN.pdf to Ned Wright's balloon analogy below (Fig. 4).

As Ned Wright explained: "The expanding balloon analogy for cosmological models is shown below at two different times. A common misconception is that the balloon is expanding into empty space that is "beyond the Universe" and that it is expanding from a single point in the center of the balloon. But the balloon analogy is a 2-dimensional model, and the center of the balloon and the space around are not part of the 2-dimensional Universe. In our 3-dimensional Universe, these points could only be reached by traveling in a 4th spatial dimension (not the time dimension of 4-D spacetime), but there is no evidence that this dimension exists."
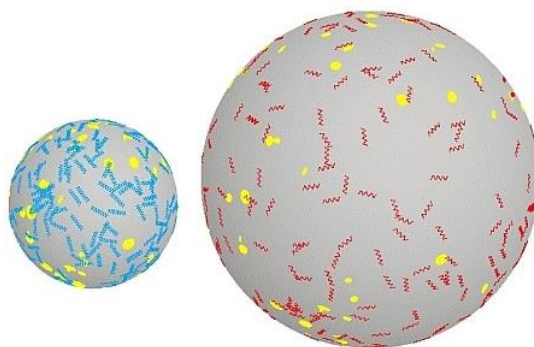
Expanding Balloon Analogy

Fig. 4

Surely there is no evidence for some "4th spatial dimension", because the *hyperimaginary* axis **W** (Fig. 4, Fig. 9.2, and Fig. 12 in CEN.pdf) is <u>not</u> topological dimension of the *physicalized* world of the Cheshire cat (Fig. 1.2). Physically, **W** (Fig. 5) is being perpetually **re-nullified** (Sec. 3 and Fig. 21.1 in spacetime.pdf).

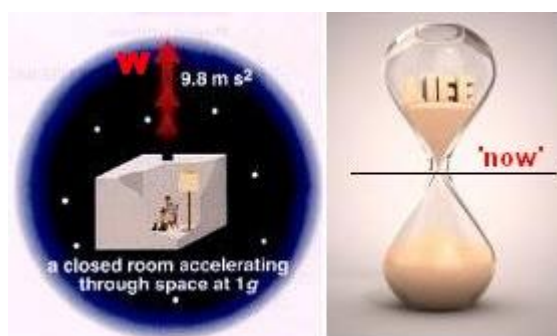Fig. 5

Physically, the *preferred* red axis **W** is "omnidirectional", that is, "beyond the Universe" (Fig. 4). Not surprisingly, Einstein's GR (Sec. 2) "does not in any way explain or obviate the principle of inertia" (Kevin Brown).

I hope this was helpful. Check out also my invitation to many prominent experts in gravitational physics and numerical relativity on p. 6 in holon.pdf.

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