

# 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 not.

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, neither ‘*is*’ nor ‘*is not*’. It is *Res potentia* – “just in the middle between possibility and reality” (Werner Heisenberg, [Slide 7](#)).

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. Here we do not offer any hypothesis on the *source* of gravity either, and instead postulate their dual existence as two *complementary* aspects of the world (cf. 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 nail varnish: we are ‘chained Eskimos’ ([Fig. 4 in CEN.pdf](#) and [Slide 14](#)), and can never see the 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 *physicalizable* 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 [Solar System](#) for which we can apply the *linearized* approximation of GR, at the expense of presenting gravity as “a powerless shadow” (cf. 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](#), much like we ignore all [quantum-wave](#) effects in [Newtonian mechanics](#). Keep in mind that our [Solar System](#) is many orders of magnitudes smaller than the [observable universe](#), so it should not be surprising that many “dark” effects of gravity, including gravitational radiation ([Sec. 3](#)), may require [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 ‘nail varnish’ ([Fig. 2](#)), and later will compare it with the localization of quantum “waves” ([Slide 7](#)).

### 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 nonconservation ([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](#), Kuchar’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](#)). Gravity is a bona fide ‘potential reality’ or *Res potentia*, which neither ‘*is*’ nor ‘*is not*’. This is the essence of *gravity-matter duality*.

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