

## Comment to a paper of M. Villata on antigravity

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**Abstract** In a recent paper of M. Villata, it is claimed that “antigravity appears as a prediction of general relativity when CPT is applied.” However, the present paper argues that Villata puts the cart before the horse qua methodology, and that the resulting theory cannot be reconciled with the ontological presuppositions of general relativity. The conclusion is that Villata’s suggestion for the physics that might underlie a gravitational repulsion of matter and antimatter is not acceptable as a fundamental theory in its current state of development.

**Keywords** Gravitational repulsion · General relativity · Foundations of physics

### 1 Introduction

In the recent paper “CPT symmetry and antimatter gravity in general relativity”, cf. (Villata 2011), the paradigm of general relativity (GR) is extended with the assumption of CPT-symmetry. By applying discrete operators for charge, parity and time inversion to the equation of motion in GR, equation (8) in Villata (2011),

$$\frac{d^2 x^\lambda}{d\tau^2} = -\frac{m_{(g)}}{m_{(i)}} \frac{dx^\mu}{d\tau} \Gamma_{\mu\nu}^\lambda \frac{dx^\nu}{d\tau} \quad (8)$$

a new equation is constructed, equation (9) in Villata (2011):

$$\frac{d^2 x^\lambda}{d\tau^2} = -\frac{m_{(g)}}{m_{(i)}} \frac{dx^\mu}{d\tau} \Gamma_{\mu\nu}^\lambda \frac{dx^\nu}{d\tau} \quad (9)$$

This is then interpreted as the equation that governs the motion of antimatter (existing in ‘our’ time-direction) in the gravitational field of ordinary matter; on that basis, Villata claims that “antigravity appears as a prediction of general relativity when CPT is applied.”

At first glance, this might be a tempting idea to obtain a description of the physics underlying gravitational repulsion. However, to start with, given that quantum physics—from where the CPT-symmetry is taken—and relativity theory are two distinct paradigms in physics that are proven to be incompatible, it is epistemologically at least a controversial practise to add a theorem of the one paradigm as an additional assumption to the other. But even if that is ignored, and even if it is assumed that the derivation of (9) from (8) is mathematically correct, the next section argues that this method of theory construction is *in itself* inadmissible, and that the theory that results from adding eq. (9) to GR cannot be reconciled with the ontological presuppositions of GR. The final section discusses the implications thereof.

### 2 Shortcomings of Villata’s method and result

CPT-symmetry is a law at the metalevel that follows from the actual laws of physics at object level. In other words, from the theory of what gravitation actually is it should be clear at object level what the process of gravitational interaction for matter is and what the process of gravitational interaction for antimatter is, and from there it should follow at the metalevel that CPT-symmetry holds (or doesn’t hold) between these processes. In theory development, it is one thing to assume a symmetry as a condition that has to be satisfied by a yet to be developed theory, but Villata puts the cart before the horse: CPT-symmetry is assumed *before-hand* and the operators C, T, and P are then used *as if* these

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