

Nonlocality in General Relativity: A missing link in Einstein's quest for a unified field theory

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Non-propagating vacuum modes in general relativity become physical when they couple to a galactic or an electrodynamic background [1]. The longitudinal vacuum mode, combined with a gauge mode, obeys a fourth order ordinary elliptic differential equation. The solution is nonlocal and reacts strongly to electrodynamic and other fluctuations in the full space-time. This causes a large, radiating gravitational cloud around an object.

In classical electrodynamics, this predicts a damping force on the motion of objects, sourced over all space-time and mediated by gravity, but independent of Newton's constant.

These findings revive Einstein's quest to derive the ontology underlying quantum mechanics with its nonlocality from a unified classical field theory. A candidate, (Linear) Stochastic Electrogravity, is considered.

- [1] T.M. Nieuwenhuizen, Exact solutions for black holes with a smooth quantum core. arXiv preprint arXiv:2302.14653 (2023)
- [2] T.M. Nieuwenhuizen, Nonlocality in General Relativity: A missing link in Einstein's quest for a unified field theory, submitted (2026)