Experimental Test of Quantum Gravity: General Relativity vs. Gauge Theory Gravity

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With recent detection of gravitational waves[1], the possibility exists that orientation-dependent detector responses might permit distinguishing between general relativity and gauge theory gravity[2]. To first order the classical equivalence of these two models was established over twenty years ago.[3–8]. The question is whether this equivalence persists in their respective quantum theories. While no such theory yet exists for the curved spacetime of general relativity, the task is not so difficult in flat Minkowski spacetime of gauge theory gravity.

The language of gauge theory gravity is geometric Clifford algebra, the background-independent[9] language of interactions of fundamental geometric objects of our physical space - the point, line, plane, and volume elements of Euclid. They are the geometric objects of the Pauli algebra of three-dimensional space, whose interactions generate the Dirac algebra of four-dimensional Minkowski spacetime[10]. Taking these to comprise the vacuum wavefunction, they permit one to define a geometric wavefunction at the Planck length, and when endowed with quantized electric and magnetic fields reveal an exact relation between electromagnetism and gravity, yielding a naturally finite, confined, and gauge invariant quantum theory that contains gravity[11–16, 21].

General relativity models the phase shifts of a gravitational wave detected by the interferometers as transverse quadrupole distortion of spacetime. Quantized gauge theory gravity models them as longitudinal quantum phase oscillations in flat Minkowski spacetime[16, 17]. As shown in the figure, the optimal interferometer responses are orthogonal for these two models.

Triangulating the source location by time of flight[18] permits one to contruct analysis templates[19, 20] for both models, admitting the possibility of an experimental test of general relativity grounded in a quantum theory of both gravity and the elementary particle spectrum[21].

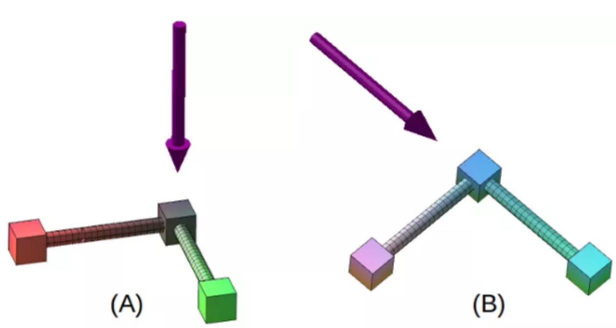

FIG. 1. Classical general relativity says interferometer response is optimal for orientation (A) and less so for (B)[18], whereas quantized gauge theory gravity is optimal for (B) and null for (A).

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