

# Quantum Gravity Experiments

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A new quantum gravity experiment is reported with the data confirming the generalisation of the Schrödinger equation to include the interaction of the wave function with dynamical space. Dynamical space turbulence, via this interaction process, raises and lowers the energy of the electron wave function, which is detected by observing consequent variations in the electron quantum barrier tunnelling rate in reverse-biased Zener diodes. This process has previously been reported and enabled the measurement of the speed of the dynamical space flow, which is consistent with numerous other detection experiments. The interaction process is dependent on the angle between the dynamical space flow velocity and the direction of the electron flow in the diode, and this dependence is experimentally demonstrated. This interaction process explains gravity as an emergent quantum process, so unifying quantum phenomena and gravity. Gravitational waves are easily detected.

## 1 Introduction

The quantum theory of gravity explains the gravitational acceleration of matter as caused by the refraction of quantum waves by the time dependence and spatial inhomogeneities of the dynamical space flow [1]. This has been tested against numerous experimental gravitational phenomena [2]: bore hole  $g$  anomalies, flat spiral galaxy rotation curves, black hole systematics and star orbit data [3], lensing of light by stars and galaxies, expanding universe supernova redshift-brightness data without need for dark matter or dark energy [4], anisotropic Brownian motion [5], directional dependence of nuclear decay rates [6]. The key initial experiments detected the dynamical space using light speed anisotropy gas-mode Michelson optical interferometers and EM speed anisotropy in RF coaxial cables. More recently quantum detectors have been discovered that directly detected the space flow [7, 8]. All these different experimental techniques reveal a turbulent space flow speed from direction RA  $\sim 4.5$ hrs, Dec= $80^\circ$ S, with a speed of  $\sim 500$  km/s. These velocities are moderated over a year by the orbital motion of the Earth.

The dynamical space quantum detectors, which use reverse biased Zener Diodes, Fig. 1 and Fig. 2, have given rise to a new critical test of the quantum theory of gravity, reported herein, namely an orientation dependent effect, which directly tests the modified Schrödinger equation which includes the effects of the dynamical space. This uses collocated quantum detectors which are either in parallel configuration or anti-parallel configuration, Fig. 3.

## 2 Quantum gravity

Dynamical space is a phenomenon repeatedly detected by a variety of experimental techniques [2]. The Schrödinger equation must be extended to include the dynamical space by using the Euler time derivative  $\partial/\partial t \rightarrow \partial/\partial t + \mathbf{v}(\mathbf{r}, t) \cdot \nabla$ , where  $\mathbf{v}(\mathbf{r}, t)$  is the classical field description of the dynamical space

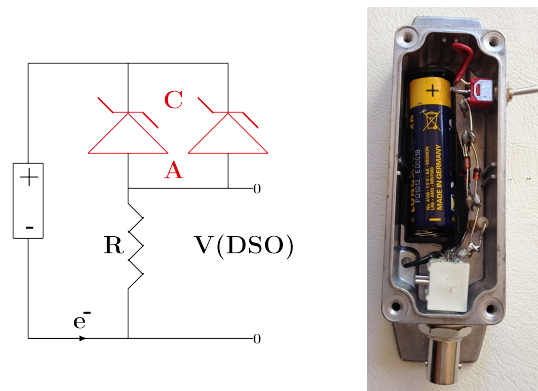


Fig. 1: Left: Circuit of Zener Diode Space Flow Detector, showing 1.5 V AA battery, two 1N4728A zener diodes operating in reverse bias mode, and having a Zener voltage of 3.3 V, and resistor  $R = 10 \text{ K}\Omega$ . Voltage  $V$  across resistor is measured and used to determine the turbulent space flow driven fluctuating tunnelling current through the Zener diodes. Correlated currents from two collocated detectors are shown in Fig. 4. Right: Photo of detector with 5 Zener diodes in parallel.

velocity:

$$i\hbar \frac{\partial \psi(\mathbf{r}, t)}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \psi(\mathbf{r}, t) + V(\mathbf{r}, t) \psi(\mathbf{r}, t) - i\hbar \mathbf{v}(\mathbf{r}, t) \cdot \nabla \psi(\mathbf{r}, t). \quad (1)$$

Here  $\mathbf{v}(\mathbf{r}, t)$  is the velocity field describing the dynamical space at a classical field level, and the coordinates  $\mathbf{r}$  give the relative location of  $\psi(\mathbf{r}, t)$  and  $\mathbf{v}(\mathbf{r}, t)$ , relative to a Euclidean embedding space, and also used by an observer to locate structures. This is not an aether embedded in a non-dynamical space, but a dynamical space which induces an

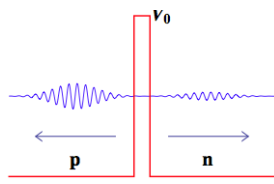


Fig. 2: Electron wave function after barrier quantum transmission and reflection from the LHS, with  $p$  and  $n$  denoting semiconductor type, showing partially transmitted component and partially reflected component, when the diode is operated in reverse-bias mode, as shown in Fig. 1. Space flow fluctuations raise and lower the energy of the incident wave function, which changes the relative magnitude of these two components.

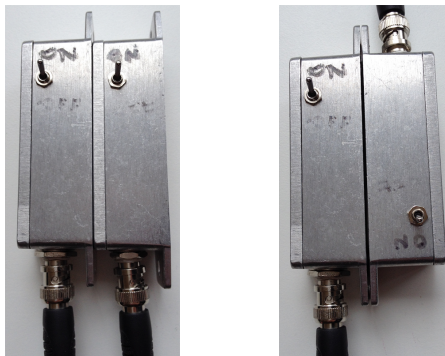


Fig. 3: Left: Two collocated detectors in parallel configuration, Right: anti-parallel configuration. The corresponding data is shown in Fig. 4. The data in Fig. 5 was obtained with one of the detectors in the parallel configuration shifted by 1cm, and together aligned with the Earth's spin axis.

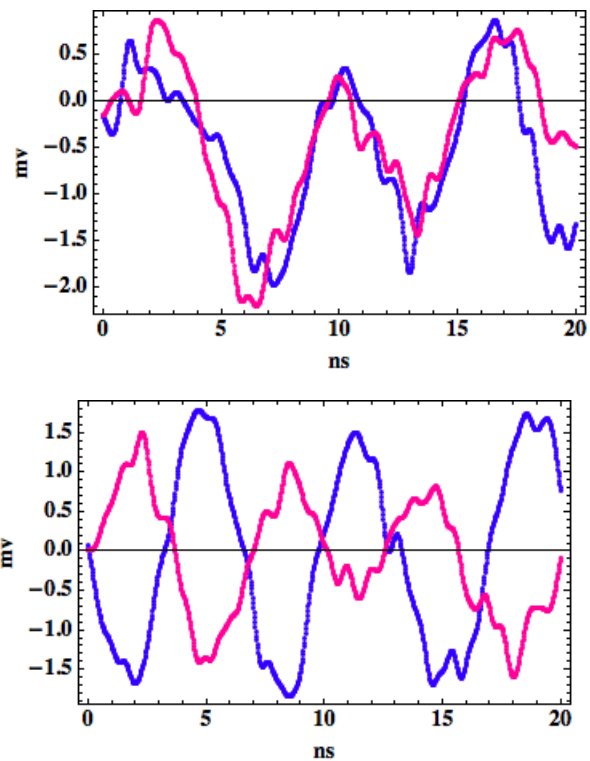


Fig. 4: Correlated current fluctuations, as indicated by voltage across resistor  $R$ , and with DSO operated with  $1\text{ M}\Omega$  AC input, and no filters. Top: From two collocated parallel detectors, as shown in Fig. 1. Bottom: Anti-correlated current fluctuations from the two collocated but anti-parallel detectors, also shown in Fig. 1. This data confirms the dynamical consequences of the  $-i\hbar\mathbf{v} \cdot \nabla\psi$  term in the new Schrödinger equation. This term is the origin of the quantum gravity.

embedding space or coordinate system. The Euler derivative was first introduced by Euler in 1757 when beginning the study of fluids, and ensures that fluid dynamics are relative to the fluid, and not fixed relative to an observer. Hertz in 1890 introduced this Euler derivative into Maxwell's EM theory, but was unaware of the meaning of  $\mathbf{v}(\mathbf{r}, t)$ . The detection of the dynamical space then mandates the use of the Euler derivative in the Schrödinger equation [1].

A significant effect follows from (1), namely the emergence of gravity as a quantum effect: an Ehrenfest wave-packet analysis reveals the classical limit and shows that the acceleration of a localised wave packet, due to the space terms alone, when  $V(\mathbf{r}, t) = 0$ , given by  $\mathbf{g} = d^2\langle\mathbf{r}\rangle/dt^2$ , gives [1]

$$g(\mathbf{r}, t) = \frac{\partial\mathbf{v}}{\partial t} + (\mathbf{v} \cdot \nabla)\mathbf{v} \tag{2}$$

That derivation showed that the acceleration is independent of the mass  $m$ : whence we have the derivation of the Weak Equivalence Principle, discovered experimentally by Galileo.

Note that the emergent quantum-theoretic matter acceleration in (2), is also, and independently, the constituent accel-

eration  $\mathbf{a}(\mathbf{r}, t)$  of the space flow velocity field,

$$\begin{aligned} \mathbf{a}(\mathbf{r}, t) &= \lim_{\Delta t \rightarrow 0} \frac{\mathbf{v}(\mathbf{r} + \mathbf{v}(\mathbf{r}, t)\Delta t, t + \Delta t) - \mathbf{v}(\mathbf{r}, t)}{\Delta t} \\ &= \frac{\partial\mathbf{v}}{\partial t} + (\mathbf{v} \cdot \nabla)\mathbf{v}. \end{aligned} \tag{3}$$

which describes the acceleration of a constituent element of space by tracking its change in velocity. This means that space has a structure that permits its velocity to be defined and detected, which experimentally has been done. This then suggests, from (2) and (3), that the simplest dynamical equation for  $\mathbf{v}(\mathbf{r}, t)$  is

$$\nabla \cdot \left( \frac{\partial\mathbf{v}}{\partial t} + (\mathbf{v} \cdot \nabla)\mathbf{v} \right) = -4\pi G\rho(\mathbf{r}, t); \quad \nabla \times \mathbf{v} = \mathbf{0} \tag{4}$$

because it then gives  $\nabla \cdot \mathbf{g} = -4\pi G\rho(\mathbf{r}, t)$ ,  $\nabla \times \mathbf{g} = \mathbf{0}$ , which is Newton's inverse square law of gravity in differential form. Hence the fundamental insight is that Newton's gravitational acceleration field  $\mathbf{g}(\mathbf{r}, t)$  for matter is really the acceleration

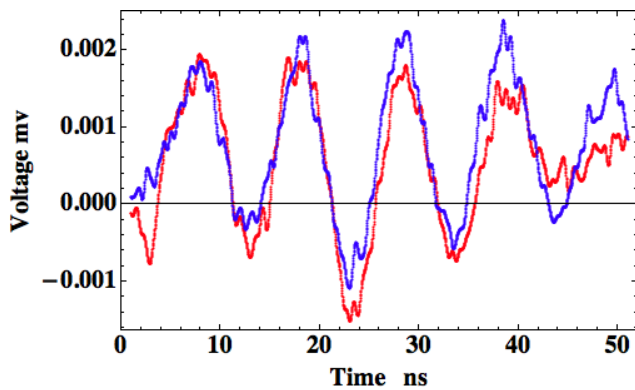


Fig. 5: Correlated current fluctuations, as indicated by voltage across resistor  $R$ , and with DSO operated with  $1\text{ M}\Omega$  AC input, and no filters. Detectors in parallel configuration, and orientated parallel to Earth axis, but offset by 1 cm, and plotted with a time offset of 20 ns, implying a speed of 500 km/s.

field  $\mathbf{a}(\mathbf{r}, t)$  of the structured dynamical space and that quantum matter acquires that acceleration because it is fundamentally a wave effect, and the wave is refracted by the accelerations of space. While (4) is the simplest 3-space dynamical equation, this derivation permits further terms which maintain Newton's inverse square law external to a spherical mass, but which otherwise leads to new observed aspects of gravity, which have previously been ascribed to "dark matter", but which are now revealed to be a dynamical aspect of space.

### 3 Quantum gravity directional experiment

The presence of the  $-i\hbar\mathbf{v}\cdot\nabla$  dynamical space term provides a critical test of the emergent quantum gravity theory. For plane wave electrons,  $\psi \sim e^{i(\mathbf{k}\cdot\mathbf{r}-\omega t)}$ , the space interaction term changes the energy of the electrons, for uniform  $\mathbf{v}$ ,

$$E = \hbar\omega \rightarrow \hbar\omega + \hbar\mathbf{k}\cdot\mathbf{v} \quad (5)$$

This space induced energy shift changes the potential energy barrier electron quantum tunnelling amplitudes in a reverse-biased Zener diode, Fig. 2. This effect is easily measured by means of the circuit in Fig. 1. A critical implication is that the electron tunnelling current must depend on the angle  $\theta$  between  $\mathbf{k}$  and  $\mathbf{v}$ , as in  $\mathbf{k}\cdot\mathbf{v} = kv \cos\theta$ . To test this effect two collocated detectors were arranged as in Fig. 3, with parallel and anti-parallel configurations. The resulting currents are shown in Fig. 4, and confirm this angle dependence effect.

As well if one of the detectors in the parallel configuration is moved by 1 cm, then a time delay effect of 20 ns is detected, as in Fig. 5. This corresponds to a spatial speed of  $\sim 500$  km/s from a S direction, as detected in numerous other experiments.

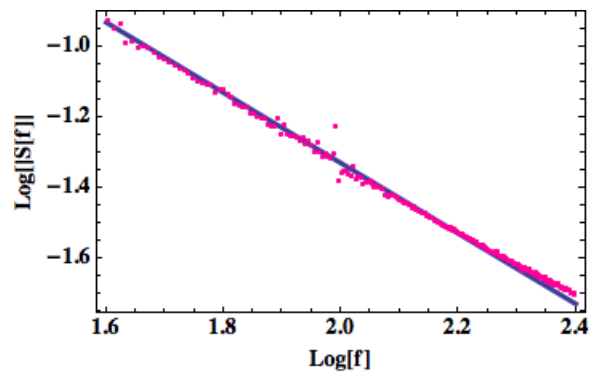


Fig. 6: Typical frequency spectrum data, showing  $\text{Log}[S[f]]$  plotted against  $\text{Log}[f]$  from the current fluctuation data, showing slope of  $-1.0$ , as the solid plot, revealing a  $1/f$  spectrum, typical of Johnson  $1/f$  electronic systems "noise", and so explaining the origin of Johnson noise [10], and also demonstrating again the fractal structure of the dynamical space.

Most electronic devices exhibit Johnson noise [10], where the electron current has a characteristic  $1/f$  spectrum. The origin of this noise has never been explained until now. The frequency spectrum for one of the current fluctuations in Fig. 4 is shown in Fig. 6, and exhibits a  $1/f$  spectrum. This implies that Johnson noise is a consequence of the fractal structure of the space flow.

### 4 Conclusions

The experimental detection of dynamical space required generalisation of Maxwell's EM Theory, Schrödinger's Quantum Theory and a corresponding generalisation of the Dirac Quantum Theory [9], and the determination of a dynamical theory for space. As a consequence it has been discovered that gravity is an emergent quantum effect. Here we have reported new key tests of this quantum theory of gravity by detecting predicted angle dependencies of quantum barrier electron tunnelling currents. The fluctuating electron currents amount to the detection of wave effects of the dynamical space: gravitational waves [11].

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