How to quantize gravity, space, and time

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Reference: “Absolute quantum gravity (AQG)”, preprint, 2026-02-28,
`https://pgu.org/absolutequantumgravity_v1.pdf`

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Overview

General relativity, while mostly nonlinear, happens to be linear with respect to certain sets of partial derivatives. We can exploit one of those linear sets in order to quantize gravity, space, and time.

The symmetric metric tensor $g_{\alpha\beta}$ in 4x4 matrix format (omitting the redundant symmetric elements) is:

$$g_{\alpha\beta} = \begin{bmatrix} g_{00} & & & \\ g_{10} & g_{11} & & \\ g_{20} & g_{21} & g_{22} & \\ g_{30} & g_{31} & g_{32} & g_{33} \end{bmatrix}. \tag{1}$$

Using x^0 as our time coordinate, the linear set of partial derivatives we are going to exploit is:

$$D_{\alpha\beta} = \begin{bmatrix} \partial_0 g_{00} & & & \\ \partial_0 g_{10} & \partial^2_{00} g_{11} & & \\ \partial_0 g_{20} & \partial^2_{00} g_{21} & \partial^2_{00} g_{22} & \\ \partial_0 g_{30} & \partial^2_{00} g_{31} & \partial^2_{00} g_{32} & \partial^2_{00} g_{33} \end{bmatrix}, \quad \text{where } \partial_0 g_{00} = \frac{\partial g_{00}}{\partial x^0}, \text{ etc.} \tag{2}$$

The derivatives of g_{00}, g_{10}, g_{20}, g_{30} are only 1^{st} order because general relativity does not contain their 2^{nd} order derivatives.

We can use ordinary linear algebra to solve general relativity for these derivatives. We can then convert partial derivatives into total derivatives by setting the coordinate system to absolute space and time. This exactly embeds general relativity into absolute space and time, which enables us to quantize gravity, space, and time.

Start from Einstein's equation for general relativity:

$$R_{\alpha\beta} - \tfrac{1}{2}\, g_{\alpha\beta} R = (8\pi K/c^4)\, T_{\alpha\beta}. \tag{3}$$

$R_{\alpha\beta}$ is the Ricci tensor, $g_{\alpha\beta}$ is the symmetric metric tensor, R is the Ricci scalar, K is the gravitational constant, c is the speed of light, and $T_{\alpha\beta}$ is the energy-momentum-stress tensor. $T_{\alpha\beta}$ is where electromagnetism lives.

To simplify notation, define $G_{\alpha\beta}$ to be the left hand side of Einstein's equation, and define $U_{\alpha\beta}$ to be the right hand side:

$$G_{\alpha\beta} = R_{\alpha\beta} - \frac{1}{2} g_{\alpha\beta} R, \qquad U_{\alpha\beta} = (8\pi K/c^4)\, T_{\alpha\beta}. \tag{4}$$

Substituting into Equation (3) gives the simplified Einstein equation:

$$G_{\alpha\beta} = U_{\alpha\beta}. \tag{5}$$

We can give labels to each element of $G_{\alpha\beta}$ and $U_{\alpha\beta}$, then display them in 4x4 matrix format as:

$$G_{\alpha\beta} = \begin{bmatrix} G_{00} & & & \\ G_{10} & G_{11} & & \\ G_{20} & G_{21} & G_{22} & \\ G_{30} & G_{31} & G_{32} & G_{33} \end{bmatrix}, \qquad U_{\alpha\beta} = \begin{bmatrix} U_{00} & & & \\ U_{10} & U_{11} & & \\ U_{20} & U_{21} & U_{22} & \\ U_{30} & U_{31} & U_{32} & U_{33} \end{bmatrix}. \tag{6}$$

Pack the symmetric 4x4 matrices into 10-vectors

$D_{\alpha\beta}$, $G_{\alpha\beta}$, and $U_{\alpha\beta}$ are symmetric, so instead of 16 independent elements, each has only 10 independent elements. Put the 10 independent elements into 10-vectors **d**, **g**, and **u**:

$$D_{\alpha\beta} \rightarrow \mathbf{d} = \begin{bmatrix} \partial_0 g_{00} \\ \partial_0 g_{10} \\ \partial_0 g_{20} \\ \partial_0 g_{30} \\ \partial^2_{00} g_{11} \\ \partial^2_{00} g_{22} \\ \partial^2_{00} g_{33} \\ \partial^2_{00} g_{21} \\ \partial^2_{00} g_{31} \\ \partial^2_{00} g_{32} \end{bmatrix}, \qquad G_{\alpha\beta} \rightarrow \mathbf{g} = \begin{bmatrix} G_{00} \\ G_{10} \\ G_{20} \\ G_{30} \\ G_{11} \\ G_{22} \\ G_{33} \\ G_{21} \\ G_{31} \\ G_{32} \end{bmatrix}, \qquad U_{\alpha\beta} \rightarrow \mathbf{u} = \begin{bmatrix} U_{00} \\ U_{10} \\ U_{20} \\ U_{30} \\ U_{11} \\ U_{22} \\ U_{33} \\ U_{21} \\ U_{31} \\ U_{32} \end{bmatrix}. \tag{7}$$

Substitute **g** and **u** into the simplified Einstein equation $G_{\alpha\beta} = U_{\alpha\beta}$ to get the vector Einstein equation:

$$\mathbf{g} = \mathbf{u}. \tag{8}$$

Solve for the time derivatives

The linearity of general relativity in $\mathbf{d}$ means that $\mathbf{g}$ and $\mathbf{u}$ can be written as linear equations in $\mathbf{d}$:

$$\mathbf{g} = \mathbf{M}\mathbf{d} + \mathbf{m}, \qquad \mathbf{u} = \mathbf{N}\mathbf{d} + \mathbf{n}, \tag{9}$$

where $\mathbf{M}$ and $\mathbf{N}$ are 10x10 matrices, and $\mathbf{m}$ and $\mathbf{n}$ are 10-vectors. Plug these expressions for $\mathbf{g}$ and $\mathbf{u}$ into the vector Einstein equation $\mathbf{g} = \mathbf{u}$:

$$\mathbf{M}\mathbf{d} + \mathbf{m} = \mathbf{N}\mathbf{d} + \mathbf{n}. \tag{10}$$

Use linear algebra to solve for $\mathbf{d}$:

$$\mathbf{d} = (\mathbf{M} - \mathbf{N})^{-1}(\mathbf{n} - \mathbf{m}) \tag{11}$$

Let $\mathbf{i}$ be the interaction terms on the right side:

$$\mathbf{i} = (\mathbf{M} - \mathbf{N})^{-1}(\mathbf{n} - \mathbf{m}). \tag{12}$$

Susbstitute $\mathbf{i}$ into (11) to get the solved Einstein equation:

$$\mathbf{d} = \mathbf{i}. \tag{13}$$

Unpack the 10-vectors into symmetric 4x4 matrices

Unpack the 10-vectors of derivatives **d** and interaction terms **i** into symmetric 4x4 matrices **D** and **I**, then relabel the elements and write them in block matrix form:

$$\mathbf{D} = \begin{bmatrix} \partial_0 g_{00} & & & \\ \partial_0 g_{10} & \partial^2_{00} g_{11} & & \\ \partial_0 g_{20} & \partial^2_{00} g_{21} & \partial^2_{00} g_{22} & \\ \partial_0 g_{30} & \partial^2_{00} g_{31} & \partial^2_{00} g_{32} & \partial^2_{00} g_{33} \end{bmatrix} = \begin{bmatrix} \partial_0 g & & & \\ \partial_0 w_1 & \partial^2_{00} S_{11} & & \\ \partial_0 w_2 & \partial^2_{00} S_{21} & \partial^2_{00} S_{22} & \\ \partial_0 w_3 & \partial^2_{00} S_{31} & \partial^2_{00} S_{32} & \partial^2_{00} S_{33} \end{bmatrix} = \begin{bmatrix} \partial_0 g & \\ \partial_0 \mathbf{w} & \partial^2_{00} \mathbf{S} \end{bmatrix}, \tag{14}$$

$$\mathbf{I} = \begin{bmatrix} \mathbf{i}_0 & & & \\ \mathbf{i}_1 & \mathbf{i}_4 & & \\ \mathbf{i}_2 & \mathbf{i}_7 & \mathbf{i}_5 & \\ \mathbf{i}_3 & \mathbf{i}_8 & \mathbf{i}_9 & \mathbf{i}_6 \end{bmatrix} = \begin{bmatrix} g_{\mathbf{i}} & & & \\ w_{\mathbf{i}_1} & S_{\mathbf{i}_{11}} & & \\ w_{\mathbf{i}_2} & S_{\mathbf{i}_{21}} & S_{\mathbf{i}_{22}} & \\ w_{\mathbf{i}_3} & S_{\mathbf{i}_{31}} & S_{\mathbf{i}_{32}} & S_{\mathbf{i}_{33}} \end{bmatrix} = \begin{bmatrix} g_{\mathbf{i}} & \\ \mathbf{w}_{\mathbf{i}} & \mathbf{S}_{\mathbf{i}} \end{bmatrix}. \tag{15}$$

Equate corresponding blocks in **D** and **I** to get the unpacked Einstein equations:

$$\partial_0 g = g_{\mathbf{i}}, \qquad \partial_0 \mathbf{w} = \mathbf{w}_{\mathbf{i}}, \qquad \partial^2_{00} \mathbf{S} = \mathbf{S}_{\mathbf{i}}. \tag{16}$$

Set the coordinate system to absolute space and time

Einstein's equation is valid in any coordinate system, so set the coordinate system to absolute space and time:

$$x^{\delta} = [ct, x, y, z]^{\intercal}. \tag{17}$$

In absolute space and time the coordinates do not vary with respect to each other:

$$\frac{dx^{\gamma}}{dx^{\delta}} = \begin{cases} 1, & \text{if } \gamma = \delta, \\ 0, & \text{if } \gamma \neq \delta. \end{cases} \tag{18}$$

1st partial derivatives become 1st total derivatives. To see this, use the standard formula for total derivatives and apply (18):

$$\frac{dg_{\mu\nu}}{dx^{\alpha}} = \frac{\partial g_{\mu\nu}}{\partial x^0}\frac{dx^0}{dx^{\alpha}} + \frac{\partial g_{\mu\nu}}{\partial x^1}\frac{dx^1}{dx^{\alpha}} + \frac{\partial g_{\mu\nu}}{\partial x^2}\frac{dx^2}{dx^{\alpha}} + \frac{\partial g_{\mu\nu}}{\partial x^3}\frac{dx^3}{dx^{\alpha}} = \frac{\partial g_{\mu\nu}}{\partial x^{\alpha}}. \tag{19}$$

Similarly for 2nd derivatives. Substitute total derivatives for the partial derivatives in the unpacked Einstein equations (16) (including those inside the interaction terms $g_{\mathbf{i}}$, $\mathbf{w}_{\mathbf{i}}$, and $\mathbf{S}_{\mathbf{i}}$), and substitute $x^0 = ct$ from (17), to convert the unpacked Einstein equations into ordinary three-dimensional differential field equations, with time t as the independent variable:

$$\frac{1}{c}\,\frac{dg}{dt} = g_{\mathbf{i}}, \qquad \frac{1}{c}\,\frac{d\mathbf{w}}{dt} = \mathbf{w}_{\mathbf{i}}, \qquad \frac{1}{c^2}\,\frac{d^2\mathbf{S}}{dt^2} = \mathbf{S}_{\mathbf{i}}. \tag{20}$$

We have reached our goal; these equation exactly embed general relativity into absolute space and time. We get exactly back to Einstein's equation if we exactly reverse the steps we took to get here.

Discussion

The field equations (20) are the fundamental equations of quantum gravity. They reduce general relativity from the tensor mathematics of curved spacetime to the scalar/vector/matrix mathematics of classical mechanics. They unite Maxwell's electromagnetism with Einstein's general relativity in Newton's absolute space and time.

The field equations (20) generate three new kinds of gravitons: scalar g gravitons, vector $\mathbf{w}$ gravitons, and matrix $\mathbf{S}$ gravitons. g, $\mathbf{w}$, and $\mathbf{S}$ stand for *g*ravitational, **w**eak, and **S**trong. The equations for the g and $\mathbf{w}$ gravitons go as d/dt, so they are diffusive or Schrödinger like. The equation for the $\mathbf{S}$ gravitons goes as d^2/dt^2, so they are wavelike or Klein-Gordon like.

The three new kinds of gravitons appear as a natural consequence of exactly embedding general relativity into absolute space and time. Unconstrained general relativity uses curved spacetime to transmit gravity. Constrained to absolute space and time, the three new kinds of gravitons mathematically pop into existence to transmit gravity.

Exactly embedding general relativity into absolute space and time also makes it straightforward to quantize space and time. Both can be quantized by using fixed step sizes. Natural choices for the space and time steps would be the Planck distance and the Planck time. Quantized space and time make it possible to simulate our universe.

For further discussion, including experimental evidence, see "Absolute quantum gravity (AQG)", preprint, 2026-02-28, `https://pgu.org/absolutequantumgravity_v1.pdf`

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