The Calculating Space Theory: A Formal Mathematical Framework

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1 Foundations of the Theory

The Calculating Space Theory (CST) postulates that space is an active processor, where interactions between elementary particles constitute computational operations. This leads to a novel interpretation of time, gravity, and physical laws.

1.1 Space as a Computational Medium

Mathematically, we define space as a discrete lattice S of interacting nodes, where each node carries state information σ_i and updates according to a transition function:

$$\sigma_i(t + \delta t) = F(\sigma_i(t), \sigma_j(t), \dots), \tag{1}$$

where j indexes neighboring nodes. The evolution of this system follows a cellular automaton model, similar to Wolfram's computational universe, but constrained by locality and interaction densities.

1.2 Particle Density and Time Dilation

The local computational rate of space is defined as:

$$R(x) = \frac{dN}{dt}, \tag{2}$$

where N is the number of state transitions per unit time at a given point x. When the density of matter increases, the available rate $R(x)$ decreases due to increased computational demand:

$$R(x) \propto \frac{1}{\rho(x)}, \tag{3}$$

where $\rho(x)$ is the local energy/mass density. The local time dilation follows from this as:

$$d\tau = R(x)dt = \frac{dt}{\sqrt{1 + \alpha\rho(x)}}, \tag{4}$$

which mirrors the gravitational time dilation from General Relativity (GR):

$$d\tau = \frac{dt}{\sqrt{1 - \frac{2GM}{c^2 r}}}. \tag{5}$$

2 Gravity as an Emergent Phenomenon

W CST grawitacja nie jest siła fundamentalna, ale wyłania sie z różnic w szybkości obliczeniowej przestrzeni. Rozważ funkcje podobna do metryki:

$$g_{00}(\mathbf{x}) = \frac{1}{\alpha(\mathbf{x})}.$$

Równanie siły dla czastki testowej wynika nastepnie z gradientu potencjału obliczeniowego:

$$\mathbf{F} = -\nabla R(\mathbf{x}).$$

If we assume a simple Newtonian mass distribution, this leads to an emergent form of Newton's law:

$$\mathbf{F} = -\frac{GmM}{r^2}, \tag{6}$$

which is traditionally derived from General Relativity but here follows directly from CST principles.

2.1 Curvature of Spacetime as an Approximation

Einstein's field equations in GR can be rewritten in a computational form:

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = \frac{8\pi G}{c^4}T_{\mu\nu}. \tag{7}$$

In CST, this corresponds to an equation governing the distribution of computational resources:

$$\nabla^2 R(x) = \beta T_{\mu\nu}, \tag{8}$$

where β is a coupling constant.

3 Implications for Quantum Mechanics

3.1 Computational Constraints and Uncertainty

CST suggests that quantum uncertainty is a natural result of discrete computational limits. The uncertainty relation can be derived as a bound on the precision of state updates:

$$\Delta x \Delta p \geq \frac{h}{2}, \tag{9}$$

where h is a consequence of discrete time evolution steps δt.

3.2 Nonlocality and Entanglement

A key challenge for CST is explaining entanglement. One proposal is that entanglement arises due to hidden computational links in the network structure, allowing nonlocal synchronization of states.

4 Future Research and Experimental Verification

4.1 Measuring Anomalous Time Dilation

A key test for CST would be detecting deviations from standard GR time dilation in extreme density environments. If CST is correct, time dilation should be influenced by local computational constraints beyond GR predictions.

4.2 Numerical Simulations

Simulating CST requires a massively parallel processing approach, akin to spin networks in Loop Quantum Gravity.

5 Summary

The Calculating Space Theory (CST) provides a computational foundation for spacetime, redefining time and gravity as emergent properties of information processing. Its mathematical framework suggests testable predictions, potentially offering a new approach to unifying General Relativity and Quantum Mechanics.