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## **Time Travel With Theoretical Physicist Sean Carroll**

Physics As Spacetime  
Geometry

In physics, spacetime is any mathematical model which fuses the three dimensions of space and the one dimension of time into a single four-dimensional manifold. Spacetime diagrams can be used to visualize relativistic effects, such as why different observers perceive differently where and when events occur.

Spacetime - Wikipedia

The identification of four-dimensional physics with the geometry of spacetime presupposes that spacetime

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represents a real four-dimensional world as Minkowski insisted since physics cannot be geometry of something abstract (here we again face the challenging question of whether a mathematical formalism is only a convenient description of physical phenomena or reveals true features of the physical world).

## Physics as Spacetime Geometry

This approach is the spirit behind the new work from Han and Hartnoll, who have used neural networks precisely to describe a system of quantum objects that, though

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simplified, captures the essential properties of spacetime geometry (Fig. 1). More specifically, they find the ground-state wave function of this many-body system, from which all of the system's properties can be determined from first principles.

Physics - Machine Learning  
Tackles Spacetime  
Spacetime and Geometry is an introductory textbook on general relativity, specifically aimed at students. Using a lucid style, Carroll first covers the foundations of the theory and mathematical formalism, providing an

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approachable introduction to what can often be an intimidating subject.

Spacetime and geometry  
introduction general  
relativity ...

Spacetime Geometry in Quantum Mechanics. How quantum gravity describes the inner workings of particle physics: the quantum geometry of entanglement - advances beyond the Copenhagen interpretation. In a recent paper by the leading theoretical physicist Leonard Susskind, director of the Stanford Institute for Theoretical Physics, a major conundrum of



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Copenhagen quantum mechanics is addressed as Susskind takes head-on the elephant-in-the-room for the major model of particle physics.

Spacetime geometry in quantum mechanics

A spacetime diagram is a graphical illustration of the properties of space and time in the special theory of relativity. Spacetime diagrams allow a qualitative understanding of the corresponding phenomena like time dilation and length contraction without mathematical equations. The history of an object's location throughout all time traces out a line, referred

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to as the object's world line, in a spacetime diagram. Points in spacetime diagrams represent a fixed position in space and time and are

Spacetime diagram -  
Wikipedia

In physics, the Lorentz transformations are a six-parameter family of linear transformations from a coordinate frame in spacetime to another frame that moves at a constant velocity relative to the former. The respective inverse transformation is then parametrized by the negative of this velocity. The transformations are

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named after the Dutch physicist Hendrik Lorentz.

Lorentz transformation -  
Wikipedia

Penrose proposed that twistor space should be the basic arena for physics from which space-time itself should emerge. It leads to a powerful set of mathematical tools that have applications to differential and integral geometry , nonlinear differential equations and representation theory and in physics to general relativity and quantum field theory , in particular to scattering amplitudes .

Twistor theory - Wikipedia

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In physics, a pregeometry is a structure from which the geometry of the universe develops. Some cosmological models feature a pregeometric universe before the Big Bang. The term was championed by John Archibald Wheeler in the 1960s and 1970s as a possible route to a theory of quantum gravity.

Pregeometry (physics) -  
Wikipedia

Readers are led from the physics of flat spacetime (special relativity), through the intricacies of differential geometry and Einstein's equations, and on to exciting applications such as black holes,

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gravitational radiation, and cosmology. From the Back Cover

Spacetime and Geometry: An Introduction to General ...  
Spacetime, reconstructed  
Theories of holographic duality feature a correspondence between a gravitational system and a strongly interacting conformal field theory (CFT) living on the system's...

Spacetime from bits |  
Science

In mathematical physics, spacetime algebra (STA) is a name for the Clifford algebra  $Cl_{1,3}(\mathbb{R})$ , or equivalently the geometric

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algebra  $G(M, 4)$ . According to David Hestenes, spacetime algebra can be particularly closely associated with the geometry of special relativity and relativistic spacetime.

Spacetime algebra -  
Wikipedia

Spacetime and Geometry is an introductory textbook on general relativity, specifically aimed at students. Using a lucid style, Carroll first covers the foundations of the theory and mathematical formalism, providing an approachable introduction to what can often be an intimidating subject.

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Spacetime and Geometry -  
Cambridge Core

Spacetime and Geometry is an introductory textbook on general relativity, specifically aimed at students. Using a lucid style, Carroll first covers the foundations of the theory and mathematical formalism, providing an approachable introduction to what can often be an intimidating subject.

Spacetime and Geometry: An Introduction to General ...  
Spacetime and Geometry is an introductory textbook on general relativity, specifically aimed at

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students. Using a lucid and approachable style, it covers the foundations of the theory, mathematical formalism, and the major applications of general relativity including black holes, gravitational waves and cosmology.

Spacetime and Geometry: An Introduction to General ...  
Geometry of a Spacetime Unit Cell The smallest components of spacetime will never be seen with the human eye as it is orders of magnitudes smaller than an atom. If an atom was the size of the Milky Way galaxy, a granule of Planck length radius would be roughly the size of



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a grain of sand on Earth.

Geometry - EWT

Readers are led from physics of flat spacetime (special relativity), through the intricacies of differential geometry and Einstein's equations, and on to exciting applications such as black holes, gravitational radiation, and cosmology. Subtle points are illuminated throughout the text by careful and entertaining exposition.

Spacetime and Geometry:

Amazon.co.uk: Carroll, Sean

...

Spacetime from bits Mark Van  
Raamsdonk In the anti-de

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Sitter/conformal field theory approach to quantum gravity, the spacetime geometry and gravitational physics of states in some quantum theory of...

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