MSc Seminar, Akos Budai

Names of students *

Gyulai László

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. Quantum theory of gravitation is composed of general relativity and quantum mechanics. Gives same results as qft at low energies, but need predictions for high energy mostly.
2. So far all theories have failed to produce QTG.
3. Idea: don't bother with classical description, start with QM and then try to get back some classical behaviour.
4. For this idea existence of particles and spacetime is not assumed. We try to find it in wavefunction.
5. For derivation we divide Hilbert space into pieces, which we can imagine as being "particles", then construct a graph with "particles" as nodes, and connections being only exchanging information.
6. For 1D model we ger one dominating eigenvalue for wavefunction, in 2D there are 2 dominating eigenvalues.
7. Changing node produces curvature in smooth space.
8. Todo: time evolution, Lorentz invariancy

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Balázs Péter, Bendegúz Sulyok

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. Currently we don't have a succesful quantum theory of gravity, because quantum gravity only appears on very high energies, which we cannot check experimentally.
2. Theories today: loop quantum gravity, string theory. These start from classical theory of gravity and try to apply quantumization.
3. Emergent spacetime: we start from a quantum description of reality, and we try to get to spacetime.
4. We create a graph of the "pieces" of the Hilbert-space, in which the edges contain mutual information. If we take a part of the graph, and we sum the inner mutual information, this information is accessible from the outside.
5. If the mutual information is big, the distance in real space is small, and vice versa.
6. Parts of the graph can be transformed into a smooth space of proper dimension.
7. Perturbations in entropy lead to curves in the corresponding real space.
8. Even wormhole-like objects can be recreated.
9. With time evolution we can also derive Einstein's equation in some special cases, if we assume Lorentz-invariance.

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Borsi Márton, Horváth Anna, Tamás Gábor

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. Difficulty: we don't have contradicting experimental results since quantum gravity appears only on high energies.
2. Idea: we do not need a classical theory, we assume that the world is quantum mechanical from the get go
3. We can define a graph with pieces (into which the Hilbert space can be divided) as nodes and with mutual information as weights of the edges.
4. One can define a metric based on the idea that the points which are closer in space have more mutual information.
6. Entropy is proportional to the volume and from the scaling the dimension can be determined.
7. The isotropic Heisenberg chain was reproduced using the presented technique.
8. Curvatures of general relativity were reproduced by perturbing the entropy.
9. Einstein's equation was reproduced with some assumptions.

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Reka Szilvasi, Zsombor Szilagyi, Zsolt Szabó

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

The talk was about the description of quantum gravity. The speaker introduced the two most famous theory of quantum gravity: string theory and loop quantum gravity, which are predictive at low energies. They start from classical theory and impose the laws of quantum mechanics. But there is another attempt: assume that the world is quantum, there is no need for a classical theory, we find the emergent classical world inside! This is the emergent spacetime approach. We don't suppose the existence of spacetime, or even particles. The structure of spacetime is encoded in a wavefunction, which is the compostition of small world wavefunctios. We can construct a graph from theese where the edge weights between the nodes correspond to mutual information and the number of edges inside a region correspond to entropy. Space can be recovered from the following idea: the more the mutual information, the closer the nodes (pieces). Smooth geometry can be obtained by a mathematical trick: multidimensional scaling. The speaker mentioned how we can get curved spacetime: by local perturbation of entropy. But also the positive curvature (corresponding to wormholes) can be recovered by nonlocal change in the mutual information. Further question is, how time evolution can be built in the model.
Note: At least one of us appreciated the topic of your talk. :)

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Kovács Panna, Szombathy Dominik

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

1. The talk was about quantum mechanics and general relativity, especially quantum theory of gravity.
2. The main attepmts to derive it were loop quantum gravity and string theory.
3. His new model assumed that the world is quantum mechanical from the very beginning.
4. This theory was represented with a graph (pieces as nodes, mutual information as weights), in which the real-life spatial relations were described with the weights between the nodes.
5. He also presented experimental results inculding a paper on this topic, discussing the ground state of 1D ferromagnetic Heisenberg spin chain and 2D toric code.
6. Introducing time-independent perturbation to the system a relation appears a relation between the curvature and the entropy perturbation.
7. With a few assumptions we could establish a relation between Einsetin's equations and this new quantum theory.
8. Ákos brought up some future research directions too, such as time evolution and emergent Lorentz-invariance.

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Varga Zoltán, Vízkeleti Áron

Summarize the talk in 5-10 numbered sentences. Some guidance: What is the physical setup presented? What are the control parameters? What are the quantities measured/calculated? Which methods were used? Is this subject particularly interesting or relevant? Why? Do you have any questions? Any comments, suggestions regarding the presentation? *

The speaker gave a talk about an attempt to formulate a quantum description of general relativity. The idea stemmed from quantum origins. It is assumed that the whole system is described with a “big” Hilbert space. We decompose this space into the tensor product of “smaller” spaces. This allows us to write the state as the product of “component” wave functions. We define a whole graph, where each node is a component space. We can also define an information content/entropy between nodes and use this as a weight in the graph. This defines a kind of metric on the graph. This led to a “smooth” dimensionally correct geometry. Local and nonlocal entropy perturbations reproduced known quantum phenomena, such as quantum teleportation. Lorentz invariance, and time invariance is yet to be explained by this description.