LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

ARNOLD SOMMERFELD CENTER FOR THEORETICAL PHYSICS

Sommerfeld Theory Colloquium

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AEI Golm

Emergent cosmology from quantum gravity: the universe as a quantum condensate

The construction of a quantum theory of gravity remains an open problem despite decades of efforts.
In time, the very perspective on this problem evolved. From quantising General Relativity, the goal is now mostly understood to be unraveling a more fundamental microstructure of spacetime, based on non-geometric building blocks, and to show how spacetime and matter emerge as effective, approximate notions. Given some candidate building blocks, the task becomes analogous to that of extracting the macroscopic, collective behaviour of the atoms of a condensed matter system, but even more challenging since we cannot use the usual spacetime intuition and no direct observational input is available to guide theory construction.
Lacking a fundamental theory of quantum gravity, existing cosmological models which have proven extremely successful in accounting for the observed features of the very early universe (via CMB data) remain without a solid foundation, having to make a number of assumptions about a physical regime (close to the big bang), where the quantum nature of gravity and spacetime is expected to be relevant. This is all the

more unfortunate, since the very early universe is also where any proposed quantum theory of gravity has the highest chance of finding its observational test-bed. The gap needs to be bridged.

In this talk I will first of all review the basic aspects of the problem of quantum gravity, and of some current approaches. I will then focus on one specific formalism for quantum gravity, so-called group field theories (strictly related to a number of other modern approaches). I will introduce its main features, trying to clarify the nature of the suggested building blocks of spacetime and their mathematical description. Next, I will outline a general strategy to extract an effective cosmological dynamics from quantum gravity, within this formalism. In this setting, the universe emerges as a quantum condensate of the fundamental "atoms of spacetime", and cosmology is its corresponding hydrodynamics. Finally, I will summarize the recent results obtained along this research direction.

Wednesday, October 18, 2017, 16:15 h, Room 348 / 349, Theresienstr. 37 / III

Prof. Dieter Lüst