Contribution ID: **9** Type: **Talk**

The continuum limit of perturbative quantum gravity

Thursday 28 November 2019 10:15 (30 minutes)

We show that quantum gravity does exist as a genuine perturbative quantum field theory (i.e. is renormalizable), with all the correct properties one would expect of such a theory: unitarity, locality, microcausality etc. However it has many novel features not seen in other quantum field theories.
Although it is perturbative in couplings it is non-perturbative in Planck's constant, and the natural direction of RG flow depends on the sector. In the high cutoff (continuum) limit the theory is governed by infinite number of such underlying couplings conjugate to interactions that violate diffeomorphism invariance. In the low cutoff regime, diffeomorphism invariance and the standard form of the amplitudes are recovered, the latter parametrised by just two effective couplings, Newton's constant and the cosmological constant. These effective couplings also determine the values of all the couplings to higher dimension operators that in the perturbatively non-renormalizable effective quantum gravity approach would have to be introduced as separate parameters.

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Session Classification: Session 1