



Contribution ID: 1

Type: poster

From fakeons to quantum gravity

Wednesday, 20 February 2019 18:03 (1 minute)

I introduce the concept of fake particle and study how it is used to formulate a consistent theory of quantum gravity. Fakeons arise from a new quantization prescription, alternative to the Feynman one, for the poles of higher-derivative theories, which avoids the problem of ghosts. The fake particles mediate interactions and simulate true particles in many situations. Nevertheless, they are not asymptotic states and cannot be detected directly. The Wick rotation and the S matrix are regionwise analytic and the amplitudes can be calculated in all regions starting from the Euclidean one by means of an unambiguous, but nonanalytic operation. By reconciling renormalizability and unitarity in higher-derivative theories, the models containing both true and fake particles are good candidates to explain quantum gravity. In pole position is the unique theory that is strictly renormalizable. One of the major physical predictions due to the fakeons is the violation of microcausality. I discuss the classical limit of the theory and the acausal corrections to the Einstein equations.

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Session Classification: Poster session

Track Classification: Beyond Einstein's Gravity