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Matter coupled to 3d Quantum Gravity: One-loop Unitarity

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We expect quantum field theories for matter to acquire intricate corrections due to their coupling to quantum fluctuations of the gravitational field. This can be precisely worked out in 3D quantum gravity: after integrating out quantum gravity, matter fields are effectively described as non-commutative quantum field theories, with quantum-deformed Lorentz symmetries. An open question remains: Are such theories unitary or not? On the one hand, since these are effective field theories obtained after integrating out high energy degrees of freedom, we may expect the loss of unitarity. On the other hand, as rigorously defined field theories built with Lorentz symmetries and standing on their own, we naturally expect the conservation of unitarity. In an effort to settle this issue, we explicitly check unitarity for a scalar field at one-loop level in both Euclidean and Lorentzian space-time signatures

Author: MARIS, Valentine (LPENSL)

Co-author: Dr LIVINE, Etera (CNRS)

Presenter: MARIS, Valentine (LPENSL)

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