Are models of quantum gravity compatible with effective field theory?

The modern understanding of our best theories of the fundamental interactions is that these theories are effective: they are a low-energy description of more fundamental but experimentally inaccessible degrees of freedom. Thereofore, as long as one performs experiments blind to such large energy scales, the outcomes should be explained from a theory involving only low energy degrees of freedom. Indeed, one does not need to take into account quark-gluon interactions to describe newton mechanics or fluid dynamics. Similarly, if nowadays a complete description of gravity at arbitrarily large scales is still considered to be out of reach, some quantum gravity effects might still be observerd at low energy.

If general relativity, our most powerful and precise classical theory of gravity, cannot be quantized as a ultraviolet complete (i.e. at arbitrary short scale or large energy) field theory, it can still be quantized as an effective field theory, i.e it means that one can get a useful description of quantum gravity as long as one does not explore enegy scales close to the Planckian regime. Therefore, it is a very interesting task to compare some ultraviolet complete models of quantum gravity, such as loop quantum gravity or string theory, to quantum gravity on an effective level. These comparisons can be a powerful tool in order to rule out some of these models, since quantum gravity as an effective field theory is a very reliable theory, and if the ultraviot description does not match the effective theory predictions then the reasons of this mismatch should be carefully investigated, and may even be a strong reason to rule out the chosen ultraviolet description.

Absence of experimental tests of quantum gravity has led us to a vast landscape of speculative theories whose connection to more well understood and well established descriptions of gravity. In his paper, Sami compared models of quantum gravity used to explain the quantum transitions between a black hole and a white hole to the effective field theory predictions of quantum gravity. His results showed that many spacetime metrics used for these models are in fact incompatible with this effective description of quantum gravity, strongly suggesting that these models cannot be a fundamental description of nature. Moreover, he computed the parameters of these symmetry-reduced models used in this kind of analysis ensuring compatibility with the effective description. These results provide an explicit link between a low-energy description of quantum gravity and more speculative high-energy completions.

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