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Testing theories of quantum gravity in the early universe

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Quantization of gravity has been a subject of intense study over half a century. But our understanding is still quite limited and in particular, the theory has not been properly established despite numerous efforts and the existence of many potential candidates. One of the main reasons is the lack of experimental evidences due to their tiny effects and both physical and mathematical challenges of the problem. In the past couple of years, we have developed a powerful, efficient and accurate mathematical method, the uniform asymptotic approximation, to study the early universe, where the energy was about the Planck energy and quantum gravitational effects become important. Up to the third-order approximations, the upper bounds of errors of the method are less than 0.15%, which is the most accurate method existing in the literature and sufficient for the current and forthcoming cosmological experiments. Applying it to loop quantum cosmology, we shall argue that the quantum gravitational effects could be well within the range of detectability of the forthcoming (such as, stage IV) observations of the cosmic microwave background radiation.

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