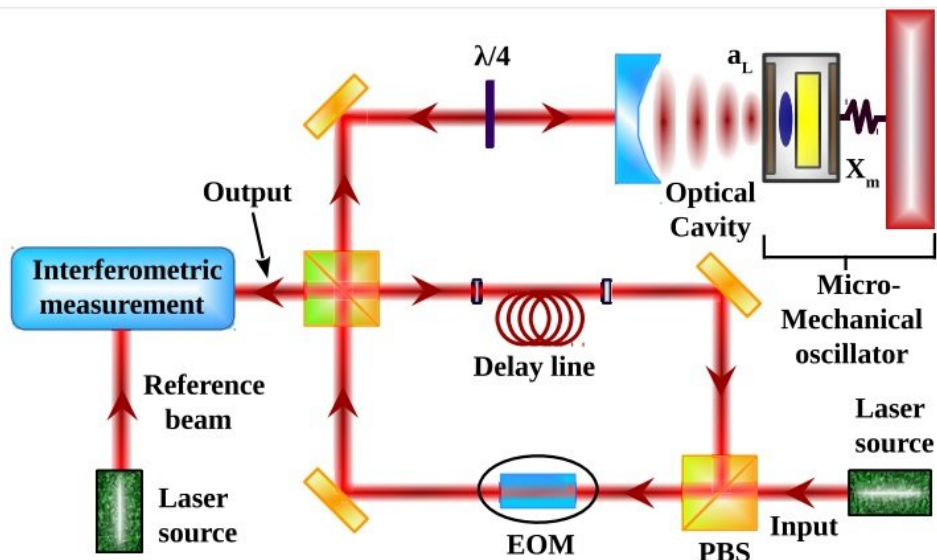


Physicists propose test of quantum gravity using current technology

October 27 2017, by Lisa Zyga



Proposed experimental setup to probe the effects of noncommutative structure. Credit: S. Dey et al. ©2017 Nuclear Physics B

Physicists have proposed a way to test quantum gravity that, in principle, could be performed by a laser-based, table-top experiment using currently available technology. Although a theory of quantum gravity would overcome one of the biggest challenges in modern physics by unifying general relativity and quantum mechanics, currently physicists

have no way of testing any proposed theories of quantum gravity.

Now a team of seven physicists from various countries, S. Dey, A. Bhat, D. Momeni, M. Faizal, A. F. Ali, T. K. Dey, and A. Rehman, have come up with a novel way to experimentally test [quantum](#) gravity using a laser-based experiment. They have published a paper on their proposed test in a recent issue of *Nuclear Physics B*.

One reason why testing quantum gravity is so challenging is that its effects appear only at very high-energy scales and their corresponding tiny length scales. These extreme scales, which are very near the Planck scale, are roughly 15 orders of magnitude beyond those accessible by the Large Hadron Collider (LHC), by far the world's highest-energy experiment.

In order to address these challenges, the physicists took a completely different approach to reaching Planck-scale energies and lengths, which is by measuring the effects of a property called noncommutativity.

Many proposed theories of quantum gravity, including [loop quantum gravity](#) and string [theory](#), are noncommutative theories, in which spacetime geometry is noncommutative. In this framework, certain parameters have noncommutative relations, a concept that is closely related to the idea of complementary variables in Heisenberg's uncertainty principle. One of the consequences of a noncommutative spacetime is that there are no singularities, which has implications for other areas of cosmology, such as the [big bang](#) and black holes.

With their proposed test, the physicists' goal is to find experimental evidence supporting the idea that spacetime does indeed have a noncommutative structure. To do this, the proposed test attempts to detect any changes in the conventional commutative relations occurring in a micromechanical oscillator. If these changes are present, they would

indicate a noncommutative structure and produce a measurable optical phase shift on a light pulse that has been coupled to the oscillator.

Using current optical setups, this phase shift can be measured with sufficiently high levels of accuracy that, according to the physicists' calculations, would make it possible to access the energy scale near the Planck length. By accessing this scale, the experiment could potentially probe the effects of noncommutative theories at the energy regime relevant to quantum gravity.

"We expect the geometry of spacetime to be an emergent structure, which emerges from some purely mathematical theory of quantum [gravity](#)," coauthor Mir Faizal, a professor at the University of British Columbia-Okanagan and the University of Lethbridge, Canada, told *Phys.org*. "This is similar to the geometry of a metal rod emerging from atomic physics. It has been suggested from various approaches to [quantum gravity](#) that this structure underlying the geometry of spacetime can be represented by noncommutative geometry. So, we have proposed a way to [test](#) this idea using an opto-mechanical experiment. The advantage of having such a structure will be that, in it, the [spacetime](#) will be free of singularities, including the big bang singularity."

More information: S. Dey, A. Bhat, D. Momeni, M. Faizal, A. F. Ali, T. K. Dey, A. Rehman. "Probing noncommutative theories with quantum optical experiments." *Nuclear Physics B*. DOI:

[10.1016/j.nuclphysb.2017.09.024](https://doi.org/10.1016/j.nuclphysb.2017.09.024)

Also at [arXiv:1710.03920](https://arxiv.org/abs/1710.03920) [quant-ph]

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