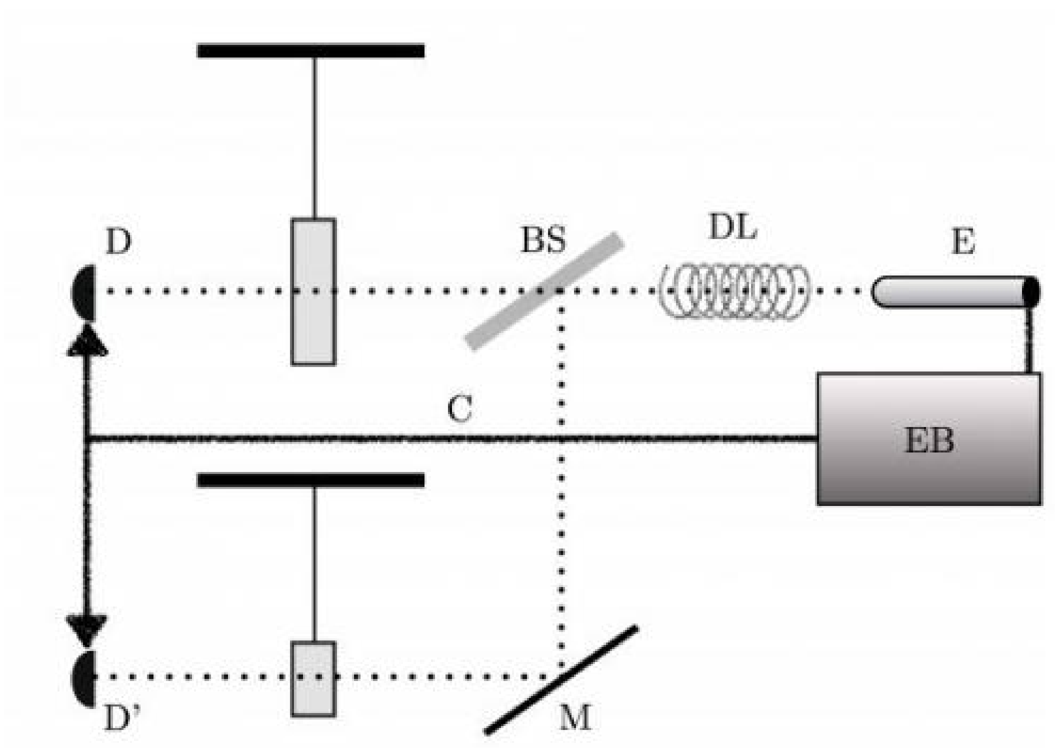
Physicist proposes simple experiment to detect foam-like structure of the universe

November 23 2012, by Bob Yirka



Set up of suspended blocks showing (dotted) the alternative paths for the photon. E is the single-photon emitter, D and D' are the single-photon detectors. BS denotes the beamsplitter and M the mirror. DL is the fi ber optics delay line, and EB are the electronics that trigger D and D' through cable C. The optical elements to widen the beam before and focus it after each block are left out for clarity. In the real experiment the blocks would hang side by side. Credit: arXiv:1211.3816 [gr-qc]

(Phys.org)—Prominent physicist Jacob D. Bekenstein, of the Hebrew University of Jerusalem, has proposed a simple experiment in a paper he's uploaded to the preprint server *arXiv*, that he says could be used to measure quantum foam. Instead of looking to ever faster particle accelerators, he proposes using an ordinary block of glass, a laser and a detector.

Quantum foam is a term used to describe the non-smooth nature of the universe. It was coined by John Wheeler who in the 1960's noted that according to quantum mechanics, certain properties of spacetime have some degree of uncertainty related to them. Later researchers have expanded on the idea, suggesting that on a quantum scale, the universe is made up of individual units which are thought to be rife with very small black holes that pop in and out of existence, resulting in foam-like images for those who try to imagine what it might look like.

Until now, trying to measure, or prove that theories about quantum foam are true have failed due to the extraordinarily small scale of the particles involved, 1.6×10^{-35}, known as the Planck length. In his paper, Bekenstein proposes an entirely new way to approach the problem. He says all that needs to be done is to fire a single photon through a block of glass and then measure how much the block moves.

The idea is to use just the right size block and wavelength of a photon such that if the photon did move the block's center of mass, it would be just one Planck length. If the universe is truly grainy, as theorized, the photon would encounter one of the tiny units which would inhibit its progress; if not, the photon would pass all the way through with no problem. Because theory suggests there are a very large number of undetectably small black holes in every part of the universe, it would seem reasonable to assume that the glass block's center of mass could fall into one, which would of course impede the movement of the block. Thus to detect the presence of theoretical foam, all researchers would have to do is fire many individual photons through a block of glass and see how many make it through using a detector on the other side.

More information: Is a tabletop search for Planck scale signals feasible, arXiv:1211.3816 [gr-qc] arxiv.org/abs/1211.3816

Abstract
Quantum gravity theory is untested experimentally. Could it be tested with tabletop experiments? While the common feeling is pessimistic, a detailed inquiry shows it possible to sidestep the onerous requirement of localization of a probe on Planck length scale. I suggest a tabletop experiment which, given state of the art ultrahigh vacuum and cryogenic technology, could already be sensitive enough to detect Planck scale signals. The experiment combines a single photon's degree of freedom with one of a macroscopic probe to test Wheeler's conception of "spacetime foam", the assertion that on length scales of the order Planck's, spacetime is no longer a smooth manifold. The scheme makes few assumptions beyond energy and momentum conservations, and is not based on a specific quantum gravity scheme.