Virtual Black Holes

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Abstract

One would expect spacetime to have a foam-like structure on the Planck scale with a very high topology. If spacetime is simply connected (which is assumed in this paper), the non-trivial homology occurs in dimension two, and spacetime can be regarded as being essentially the topological sum of $S^2 \times S^2$ and $K3$ bubbles. Comparison with the instantons for pair creation of black holes shows that the $S^2 \times S^2$ bubbles can be interpreted as closed loops of virtual black holes. It is shown that scattering in such topological fluctuations leads to loss of quantum coherence, or in other words, to a superscattering matrix \$ that does not factorise into an S matrix and its adjoint. This loss of quantum coherence is very small at low energies for everything except scalar fields, leading to the prediction that we may never observe the Higgs particle. Another possible observational consequence may be that the θ angle of QCD is zero without having to invoke the problematical existence of a light axion. The picture of virtual black holes given here also suggests that macroscopic black holes will evaporate down to the Planck size and then disappear in the sea of virtual black holes.