MINIMAL CONFIGURATION IN SIMPLICIAL QUANTUM GRAVITY WITH TOROIDAL TOPOLOGY*

Dániel Németh

Eötvös Loránd Science University
Pázmány Péter sétány 1/A, 1117 Budapest, Hungary
and
The M. Smoluchowski Institute of Physics, Jagiellonian University
Łojasiewicza 11, 30-348 Kraków, Poland

Numerical methods are playing a key role in modern science, without them most of the recent approaches and results would be unreachable. To understand the structure and behaviour of the lattice-based systems (as in Causal Dynamical Triangulation (CDT)), one can use random walks via Monte Carlo simulations and measure some relevant observables with the help of it. The recent research in CDT [1] has shown that there are differences between the toroidal and spherical conditions. Furthermore, under toroidal condition, we found an interesting result after making the configuration shrink. The size and amount of vertices of the minimal configuration (Fig. 1) became much smaller than the triangulation of a hypercube [2], which is the basic element of the initial condition. Moreover, each spacelike slice built up only from this particular set of triangles, however it is not obvious that it keeps the toroidal condition. To prove it, one should have a closer look at the configuration. It was shown that the minimal configuration includes two different types of links, one with coordination number 4 and one with coordination number 6, where the coordination number denotes the number of simplices around a link. Due to this attribute, a layered structure can be defined on this minimal configuration, each of that including five periodically repeated set of vertices. After introducing weightfactors connected to the links, three different equivalence classes of noncontractible loops (built up from attached links) can be distinguished. Finding these different loops proves that the minimal configuration still keeps the attributes of the toroidal condition.
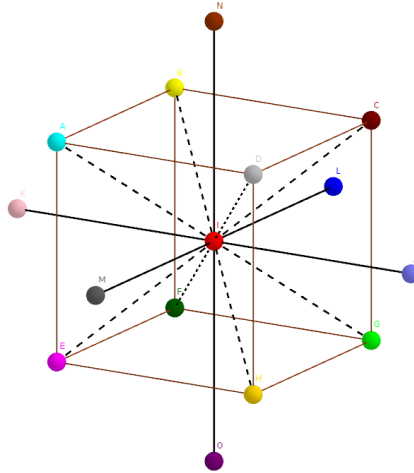

Fig. 1. The configuration including 15 identical vertices.

Lastly, it is also worth to mention that measuring the minimal configuration has some practical benefits. The features of the minimal configuration are not neglectable, because they could be responsible for the finite size effects that one can face during the simulations. These effects played role in the spherical case too, but in the toroidal condition they are more significant.

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