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On the spectral dimensionality of quantum spacetimes

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The spectral dimension is one of definitions of the effective dimensionality of spacetime that is commonly applied to characterize quantum gravity models. A quite universal prediction is the dimensional reduction to 2 in the UV regime. The notion of spectral dimension can be seen as arising from properties of either a (fictitious) diffusion process or spectral geometry. In the latter context, there also exists the related notion of dimension spectrum. The application of both concepts may lead to various pitfalls; they are actually associated with the heat trace expansion, which is an important tool in quantum field theory. Furthermore, quantum spacetime is often described in terms of broadly understood noncommutative geometry, which requires even more care. It turns out that the spectral dimension and dimension spectrum complement each other, as can be illustrated with the use of two contrasting examples: the quantum sphere and κ-Minkowski spacetime, with different possible choices of Laplacians that determine their geometries. In the former case, we also observe curious oscillations of dimension in the UV regime (which could leave an imprint on the cosmic microwave background).

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