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High Energy Physics - Theory

Geometry of fractional spaces

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We introduce fractional flat space, described by a continuous geometry with constant non-integer Hausdorff and spectral dimensions. This is the analogue of Euclidean space, but with anomalous scaling and diffusion properties. The basic tool is fractional calculus, which is cast in a way convenient for the definition of the differential structure, distances, volumes, and symmetries. By an extensive use of concepts and techniques of fractal geometry, we clarify the relation between fractional calculus and fractals, showing that fractional spaces can be regarded as fractals when the ratio of their Hausdorff and spectral dimension is greater than one. All the results are analytic and constitute the foundation for field theories living on multi-fractal spacetimes, which are presented in a companion paper.

Comments:	1+79 pages, 6 figures, 4 tables. v2: section 5 revised, final result on spectral dimension unchanged but strengthened
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