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Multifractal behaviour of n-simplex lattice

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Abstract. We study the asymptotic behaviour of resistance scaling and fluctuation of resistance that give rise to flicker noise in an *n*-simplex lattice. We propose a simple method to calculate the resistance scaling and give a closed-form formula to calculate the exponent, β_L, associated with resistance scaling, for any n. Using current cumulant method we calculate the exact noise exponent for *n*-simplex lattices.

Keywords. Percolation; fractal; multifractal.

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1. Introduction

In recent years considerable attention has been devoted to studying the properties of disordered systems with the hope of understanding percolative phenomena. Key to several such approaches has been the concept of randomness and also of frustration [1–12]. However, many of the patterns we encounter in nature are not random but self-similar and scale invariant [13,14]. For instance, the complicated and scale invariant structures that occur when a solid mixture evolves via an aggregation process [15]. To understand such systems the concept of fractals has been found to be very useful. Fractals are scale invariant objects that may be considered as intermediate lattices between regular and random (disordered) lattices [13,14,16,17]. Such a fractal lattice describes a class of random systems where the consequence of the loss of translational invariance of a lattice can be studied in detail. Additionally, resulting from their dialational symmetry, statistical, mechanical and transport problems are solvable; hence the attraction of the model in such studies [14].

In this paper we consider a particular class of fractal known as the n-simplex lattices, to model various properties of inhomogeneous materials [16,17]. The lattice is defined recursively. The map of the zero-order truncated n-simplex lattice is a complete set of $(n+1)$ points. The map of the $(r+1)$th order n-simplex lattice is obtained by replacing

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References

[1] S Washburn and R A Webb, *Rep. Prog. Phys.* **55**, 1311 (1992)
[2] A K Sen, *Mod. Phys. Lett.* **B11**, 555 (1997)
[3] V I Kozub and A M Rudin, *Phys. Rev.* **B53**, 5356 (1996)
[4] A G Hunt, *J. Phys. Condensed Matter* **10**, L303 (1998)
[5] A K Gupta, A M Jayannavar and A K Sen, *J. Phys. (Paris)* **3**, 1671 (1993)
[6] M James *et al*, *Phys. Rev. Lett.* **56**, 2280 (1986)
[7] Y Gefen, A Aharony, B B Mandelbrot and S Kirkpatrick, *Phys. Rev. Lett.* **47**, 1771 (1981)
[8] B W Southern and A R Douchant, *Phys. Rev. Lett.* **55**, 1148 (1985)
[9] B Docut and R Rammal, *Phys. Rev. Lett.*, **55**, 1148 (1985)
[10] I Zivic, S Milosevic and H E Stanley, *Phys. Rev.* **E47**, 2340 (1990)
[11] D C Hong and H E Stanley, *J. Phys.* **A16**, L525 (1983)
[12] H J Herrmann, D C Honmg and H E Stanley, *J. Phys.* **A17**, L261 (1984)
[13] B B Mandelbrot, *The fractal geometry of nature* (Freeman, NY, 1982)
[14] L Pietronero and E Tosatti (eds), *Fractals in physics* (North Holland, Amsterdam, 1986)
[15] D Kessler, J Koplick and H Levine, *Adv. Phys.* **37**, 255 (1988)
[16] D R Nelson and M E Fisher, *Ann. Phys.* **91**, 266 (1975)
[17] D Dhar, *J. Math. Phys.* **18**, 577 (1977)
[18] S Roux and C D Mitescu, *Phys. Rev.* **B35**, 898 (1987)
[19] R Rammal, C Tannous and A M S Tremblay, *Phys. Rev. Lett.* **54**, 1718 (1985)
[20] R Rammal, C Tannous and A M S Tremblay, *Phys. Rev.* **A31**, 2662 (1985)
L De Arcangelis, S Redner and A Coniglio, *Phys. Rev.* **B31**, 4725 (1985)
L de Arcangelis, S Redner and A Coniglio, *Phys. Rev.* **B34**, 4656 (1986)
[21] P Alstrom, D Stassinopoulos and H E Stanley, *Physica* **A153**, 20 (1988)
[22] P Y Tong and K W Yu, *Phys. Lett* **A160**, 293 (1991)