Random walks on regular networks generated by fractional Laplacian matrices

B. Collet[1], T. Michelitsch[1], A. Perez Riascos[2], A. Nowakowski[3], F. Nicolleau[3]

[1]Institut Jean le Rond d'Alembert, CNRS, Paris, France

[2]Department of Civil Engineering, Universidad Mariana, San Juan de Pasto, Colombia

[3]Sheffield Fluid Mechanics Group, University of Sheffield, UK

We analyze some characteristic features of random walks generated by power law matrix functions $L^{\alpha/2}$ ('fractional Laplacian matrices'). 0ge world network with only next neighbor connections such as for instance of the classical Polya walk [1,2]. We confine in this model on 'regular networks' having constant degrees for all nodes and specify our calculations on $n = 1; 2; 3; 4$-dimensional periodic and infinite lattices.

We demonstrate that the non-locality of the fractional Laplacian matrix generating connections with 'intensities' of asymptotic power law decay between all nodes, leads to the emergence of a small world property and of Lévy flights (anomalous diffusion with long-distance jumps).

In this presentation we further discuss characteristics such as first passage probabilities including first return probabilities and mean first passage times (MFPT) for the fractional random walk. Our results confirm our recent findings [3,4] that a search strategy based on a fractional random walk is faster than a search strategy based on the normal random walk ($\alpha = 2$).

[l] G. Polya, Mathematische Annale **83**, 149 (1921).

[2] E.W. Montroll, J. SIAM **4/4**, 241 (1956).

[3] T.M. Michelitsch, B.A. Collet, J. Phys. A **50**, 50 (2017).

[4] A.P. Riascos, J.L. L. Mateos, Phys. Rev. E **90**, 032809 (2014).