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Subdiffusion in complex comb-like structures and garlands.

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Abstract:

In this work we investigate subdiffusion in complex structures like complex comb-like structures or garlands. We start with a simple model of a comb structure:

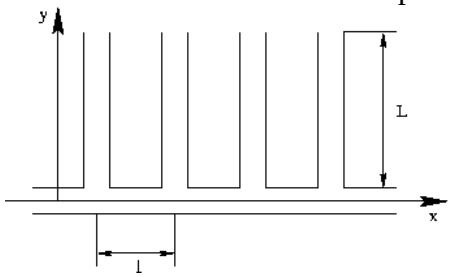

Fig.1 Comb structure of the order k=1.
V.E.Arkhincheev, E.M. Baskin, JETP, **73,** 161, 1991

Then we transform comb structure to a more complex object by replacing each branch by a similar comb structure. Further we proceed such replacing with each branch. Fig. 2 represents complex comb-like structure after two replacements:

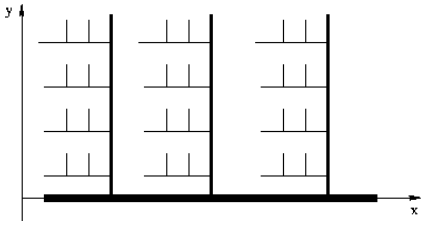

Fig.2 Complex comb-like structure of the order k=3

The equation for the particle density along the "spine" contains fractional time derivative. The comb structure on Fig.1 has fractional time derivative of order 1/2. Complex comb-like structures have fractional time derivative of order $\alpha = 1/2^k$, where k is the order of a comb-like structure. The equation for the particle density $N(x,t)$ has the following form:

$$\left(\frac{l^2}{D}\right)^{\alpha} \frac{\partial^{\alpha} N(x,t)}{\partial t^{\alpha}} = l^2 \frac{\partial^2 N(x,t)}{\partial x^2} + N_0(x)\left(\frac{l^2}{D}\right)^{\alpha} \frac{1}{\Gamma(1-\alpha)t^{\alpha}}. \quad (1)$$

We solve several problems involving such structures. Comb-like structures can be used as effective barriers for flow of particles. We consider a problem of evolution of particles in a system of butt-joined structures with factors . Structure with lowest factor take inside all particles (branchiate structure takes particles more efficiently). One may construct structures with spatially dependent fractional time derivative as well. Instead of "branches" in comb structure (Fig.1) one can place 2d discs or spheres. These structures look like garlands. Structures with disks are described by integro-differential equation. For spheres evolution stops after the diffusion time between them, because spheres take inside all particles from "spine" during this diffusion time.