# Single file dynamics/ Ophir Flomenbom

The basic single file process is the diffusion of *N* ($N \to \infty$) identical Brownian hard spheres in a quasi-one-dimensional channel of length *L* ($L \to \infty$), such that the spheres do not jump one on top of the other, and the average particle's density is approximately fixed. The most known statistical properties in this process are that the mean square displacement (*MSD*) of a particle in the file follows, $MSD \sim t^{1/2}$ and its probability density function (*PDF*) is a Gaussian in position with a variance, *MSD*.

I'LL focus in the talk on three new variants in file dynamics and address the following questions:
(*) First, the question about the origin of the unique scaling, $MSD \sim t^{1/2}$, in simple files, is addressed using scaling law analysis and a new approach for full mathematical computations in normal files.

(*) The MSD is derived in normal files with particles' density that is not fixed and with particles that are not identical, yet, the diffusion coefficients of the particles are distributed according to a probability density function. Results in these files follow:

- In files with a density law that is not fixed, but decays as a power law with an exponent *a* with the distance from the origin, the particle in the origin has a *MSD* that scales like, $MSD \sim t^{[1+a]/2}$, with a Gaussian *PDF* [1].
- When, in addition, the particles' diffusion coefficients are distributed like a power law with exponent γ (around the origin), the *MSD* follows, $MSD \sim t^{[1-\gamma]/[2/(1+a)-\gamma]}$, with a Gaussian *PDF* [2].

(*) Files with anomalous basic dynamics, both renewal ones and those that are not renewal are solved. Results in these files follow:

- In anomalous files that are renewal, namely, when all particles attempt a jump together, yet, with jumping times taken from a distribution that decays as a power law with an exponent, $-1-\alpha$, $\psi(t) \sim t^{-1-\alpha}$,the MSD scales like the MSD of the corresponding normal file, in the power of α [3].
- In anomalous files of independent particles, the *MSD* is very slow and scales like, $MSD \sim log^2(t)$. Even more exciting, the particles form clusters in such files, defining a dynamical phase transition. This depends on the anomaly power α: the percentage of particles in clusters ξ follows, $\xi = \sqrt{1-\alpha^3}$ [4].

I’ll also talk about applications of file dynamics in several fields in applied chemistry and biophysics. These include: (a) the dynamics of molecules in channels, (b) the passage of molecules along 1d objects, (c) conductance in nano-wires, etc. The talk should interest both mathematical and applied chemists, physicists and biophysicists.



***References***


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