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Joel LEBOWITZ - The Structure Function of Random Point Processes: Fluctuations and Rigidity

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We consider a translation invariant point process in R^d or Z^d. Let $V(N_B)$ be the variance in the number of points, N_B, in a ball B of volume |B|. Generally, such as when particles with short range interactions are distributed according to a Gibbs measure, $V(N_B)/|B| >0$.

There are however many interesting cases when $Var(N_B)/N_B \to 0$, as $|B| \to \infty$. Such processes are called hyperuniform (or superhomogeneous)

This occurs when the structure function S(k), the Fourier transform of the "full" pair correlation function, $G(r)=n\delta(r)+n^2[g(r)-1]$, n being the density, which is always non-negative, vanishes at k=0, S(k)=0. Just how fast $V(N_B)/|B|$ goes to zero depends on the way S(k) behaves as $k \to 0$.

I will discuss examples of such hyperuniform systems both old (Coulomb systems) and recent (facilitated exclusion processes).

When S(k) vanishes in an open set M in k-space (which may or may not include the origin) the system is maximally "rigid". Rigidity describes the amount of information about the points in B given the configuration of points outside B. This can be zero as in a Poisson process or "maximal" where the exact position of the points in B are determined by the configuration outside B.

Such systems also have other "crystaline" properties. (This is joint work with Subhro Gosh)

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