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Baruch MEERSON - Fluctuations of "Brownian bees" and of some other interacting particle systems with reset

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The "Brownian bees"model, suggested by J. Berestycki, E. Brunet, J. Nolen, and S. Penington, is a new member of a family of Brunet-Derrida particle systems which mimic some aspects of biological selection. Like other Brunet-Derrida systems, the Brownian bees can be also considered as a system of interacting particles with reset. The model describes an ensemble of N independent branching Brownian particles. When a particle branches into two particles, the particle farthest from the origin is eliminated so as to keep the number of particles constant. In the limit of $N \to \infty$, the coarse-grained particle density is governed by the solution of a free boundary problem for a simple reaction-diffusion equation. At long times the particle density approaches a spherically symmetric steady-state solution with a compact support. We studied fluctuations of the "swarm of bees"due to the random character of the branching Brownian motion in the limit of large but finite N, and we focused on the fluctuations of the swarm radius l(t) in 1d [1]. We found that the autocorrelation function of l(t) in the steady state, $g(\tau)$, exhibits a logarithmic scaling with τ=t1-t2, which corresponds to a 1/f noise in the frequency domain. The variance of l(t) exhibits an anomalous scaling (1/N) ln N with N. These anomalies appear because a broad range of spatial scales contribute to the fluctuations. I will also briefly consider another model - an N-particle system with reset of the farthest particle to the origin [2] - which shares these anomalies.

[1] M. Siboni, P. Sasorov and B. Meerson, Fluctuations of a swarm of Brownian bees. Phys. Rev. E 104, 054131 (2021).
[2] O. Vilk, M. Assaf and B. Meerson, Fluctuations and first-passage properties of systems of Brownian particles with reset. Phys. Rev. E 106, 024117 (2022).

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