SEMPARIS – Séminaires en région parisienne

http ://string.lpthe.jussieu.fr/semparis/

Séminaire de biophysique ENS-ESPCI

Vendredi 18 Fevrier 2022, 13 :00
LPENS, Zoom(Join Zoom Meeting https ://us02web.zoom.us/j/82507718742 ?pwd=T1BzU096am
Meeting ID : 825 0771 8742 Passcode : 608725)
Domaines : physics.bio-ph

Titre : *Natural swarms in 3.99 dimensions*

Orateur : **Andrea Cavagna (Instituto dei Sistemi Complessi, Rome)**

Résumé : *Collective behaviour is found in a startling variety of biological systems, from clusters of bacteria and colonies of cells, up to insect swarms, bird flocks, and vertebrate groups. A unifying ingredient is the presence of strong correlations : experiments in bird flocks, fish schools, mammal herds, insect swarms, bacterial clusters and proteins, have found that the correlation length is significantly larger than the microscopic scales. In the case of natural swarms of insects another key hallmark of statistical physics has been verified, namely dynamic scaling : spatial and temporal relaxation are entangled into one simple law, so that the relaxation time scales as a power of the correlation length, thus defining the dynamical critical exponent, z. Within statistical physics, strong correlations and scaling laws are the two stepping stones leading to the Renormalization Group (RG) : when we coarse-grain short-scale fluctuations, the parameters of different models flow towards one common fixed point ruling their large-scale behaviour. RG fixed points therefore organize into few universality classes the macroscopic behaviour of strongly correlated systems, thus providing parameter-free predictions of the collective behaviour. Biology is vastly more complex than physics, but the widespread presence of strong correlations and the validity of scaling laws can hardly be considered a coincidence, and they rather call for an exploration of the correlation-scaling-RG path also in collective biological systems. However, to date there is yet no successful test of an RG prediction against experimental data on living systems. In this talk I will apply the renormalization group to the dynamics of natural swarms of insects. Swarms of midges in the field are strongly correlated systems, obeying dynamic scaling with*

*an experimental exponent z 1.2, significantly smaller than the naive value z = 2 of equilibrium overdamped dynamics. I will show that this anomalous exponent can indeed be reproduced by an RG calculation, provided that off-equilibrium activity *and* inertial dynamics, are both taken into account; the theory gives z=1.3, a value closer to the experimental exponent than any previous theoretical determination. This successful result is a significant step towards testing the core idea of the RG even at the biological level, namely that integrating out the short-scale details of a strongly correlated system impacts on its large-scale behaviour by introducing anomalies in the dimensions of the physical quantities. In the light of this, it is fair to hope that the renormalization group, with its most fruitful consequence – universality – may have indeed an incisive impact also in biology.*
