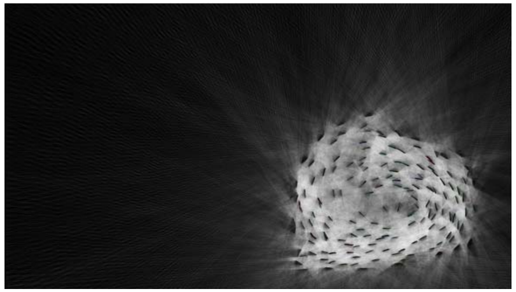
Physikalisches Kolloquium

Universität Konstanz

Di 22.11.16
15:15 Uhr
14:45 Uhr, Kaffee/Tee
R 513

Prof. Dr. Iain Couzin
Fachbereich Biologie
Universität Konstanz

Physical Computation in Animal Groups



Understanding how social influence shapes biological processes is a central challenge in contemporary science, essential for achieving progress in a variety of fields ranging from the organization and evolution of coordinated collective action among cells, or animals, to the dynamics of information exchange in human societies. Using an integrated experimental and theoretical approach I will address how, and why, animals exhibit highly-coordinated collective behavior. I will demonstrate new imaging technology that allows us to reconstruct (automatically) the dynamic, time-varying networks that correspond to the visual cues employed by organisms when making movement decisions. Sensory networks are shown to provide a much more accurate representation of how social influence propagates in groups than previous “social force” approaches derived from statistical physics. Their analysis allows us to identify, for any instant in time, the most socially-influential individuals within groups, and to predict the magnitude of complex behavioral cascades before they actually occur. I will also investigate the coupling between spatial and information dynamics in groups and reveal that emergent problem solving is the predominant mechanism by which mobile groups sense, and respond to complex environmental gradients. Evolutionary modeling demonstrates such ‘physical computation’ (involving kinetic phase transitions) readily evolves within populations of selfish organisms, and allowing individuals to compute collectively the spatial distribution of resources and to allocate themselves effectively among distinct, and distant, resource patches, without requiring information about the number, location or size of patches. Finally I will reveal the critical role uninformed, or unbiased, individuals play in effecting fast and democratic consensus decision-making in collectives, and will test these predictions with experiments involving schooling fish and wild baboons. Important features of collective decision making among these organisms are shown to be captured effectively by a novel formulation of well-characterized physical spin systems, enhancing our understanding of physical computation in biological collectives, and suggesting new avenues to explore in the collective dynamics of physical spins.