

QUANTITATIVE LAWS II

From physiology to ecology
From interaction structures to collective behavior

Villa del Grumello
Como, Italy

13 – 24 June 2016

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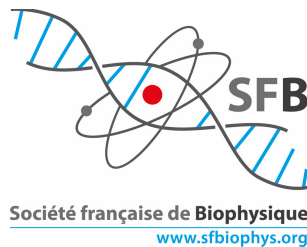
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Welcome from the Organizers

IT IS OUR PLEASURE TO WELCOME YOU TO THIS WORKSHOP. This is the second of a series of two events. We enjoyed the 2013 event so much that we have doubled it: the 2016 workshop spans two back-to-back thematic weeks of five days each on different but connected topics. We have done our best to make it attractive in terms of both venue and scientific program, and we truly believe in the potential role of such a meeting in strengthening the interdisciplinary bonds between people asking similar questions using different scientific languages. It will be up to all of us to make this potential come true. We sincerely hope that you will enjoy the meeting and the coasts of Lake Como.

Marco Cosentino Lagomarsino
Matteo Osella
Fabrizio Capuani
Federico Bassetti
Marco Gherardi

Welcome from the Lake Como School of Advanced Studies

WE WELCOME ALL OF YOU to the “Lake Como School of Advanced Studies”, an Institution originating from the synergy of four Universities of the area: U. of Insubria, U. of Milano, U. of Milano Bicocca, U. of Pavia. The School having the Complex Systems at the core of its scientific interests, we consider a really special opportunity to support a interdisciplinary meeting on Quantitative Laws in different scientific contexts. We will do our best to make your stay a pleasant and fruitful one.

Vincenzo Gino Benza
Giulio Casati

About the Workshop

QUANTITATIVE APPROACHES to evolutionary genomics, systems biology, ecology and in general to complex systems unravel several universal regularities connecting large-scale observables. These empirical trends often transcend the particular details of the biological site or system. Consequently, a current challenge for theoreticians is to understand how the different universal features emerge. The goal is to rationalise the empirical regularities by physical principles and mathematical models. The exploration of quantitative laws spans a multitude of levels from physiology to evolutionary genomics, from ecology to sociology.

The scope of this workshop is to give an overview of the current state of the field and put a researcher in the condition of performing research at the edge of the current knowledge. The workshop targets PhD students and postdocs, as well as more experienced researchers with background in physics, (evolutionary) genomics, (evolutionary) biology, ecology, and complex systems, interested in quantitative work. We aim to bring together scientists from different fields, and whose research contributed to the understanding of relevant empirical data.

The workshop is divided in two thematic weeks, centered on results, discoveries and methods at the interface of statistical physics, biology and complex systems:

FROM PHYSIOLOGY TO ECOLOGY (WEEK1) — Recent quantitative measurements in biology, ecology and genomics uncover regular patterns connecting genomes, phenotypes and physiological traits. Some of these universals might qualify as “biological laws” in a similar sense as “law” is understood in modern physics. Focusing on microorganisms, a current challenge for experimentalists and theoreticians is the understanding of the interplay between growth, metabolism and interactions of ecological origin (which develop even in evolving “clonal” populations). The objective of this week is to review the state of the art in the field, exploring quantitative laws at different levels, from physiology to ecosystems.





FROM INTERACTION STRUCTURES TO COLLECTIVE BEHAVIOR (WEEK2) — Contemporary science lives an exciting and challenging time in a variety of fields, with the collection of unprecedented amounts of high-quality data such that the discovery of new phenomena nearly outpaces our capability of theoretical descriptions. Particularly active areas include diverse fields, ranging from biology and ecology, to the science of artificial systems. In such areas, interaction structures lie at the heart of an interdisciplinary approach aimed at formulating quantitative laws, in the spirit of physics. This week will address the common challenge of understanding the complex relations between the collective patterns and the internal structure of the system.

Workshop Program



Week 1 — From physiology to ecology

Monday, June 13, 2016 — Morning session	
9:30 – 10:00	Welcome
10:00 – 11:00	 N. Mitarai (Lecture) <i>Bacteria growth and translation</i>
11:00 – 11:30	 Coffee Break
11:30 – 12:15	A. Celani, <i>Infomax strategies for an optimal balance between exploration and exploitation</i>
12:15 – 13:00	J. Weitz, <i>Virus-microbe dynamics: history, principles, and current challenges</i>
13:00 – 14:30	 Lunch
Monday, June 13, 2016 — Afternoon session	
14:30 – 15:15	M. Marsili, <i>Statistical mechanics of general equilibrium economies</i>
15:15 – 15:35	A. Couce, <i>Predicting genetic diversity of spontaneous drug-resistance in bacteria</i>
15:40 – 16:00	G.I. Hagstrom, <i>The effect of resource ratios on nutrient limitation and biogeochemical cycles in the ocean</i>
16:00 – 16:30	 Coffe Break
16:30 – 17:00	T.S. Hatakeyama, <i>Reciprocity between robustness and plasticity as a universal quantitative law in biology</i>
17:00 – 17:20	L. Ciandrini, <i>A quantitative view on mRNA translation: the relative role of initiation and elongation</i>
17:25 – 17:40	 Flash Talks
	G. Malaguti, <i>Fundamental resources limiting the accuracy of information transmission in cellular sensing systems for time-varying signals</i>
	G. Diana, <i>Genetic switch between redundancy and synergy in a multicellular gene expression code</i>
	Q. Zhang, <i>Separation of time scales and robustness in S phase duration</i>


Tuesday, June 14, 2016 — Morning session




9:00 – 10:00		A. De Martino (Lecture) <i>Metabolic costs of growth</i>
10:00 – 11:00		C. Quince (Lecture)
11:00 – 11:30		Coffee Break
11:30 – 11:50		L. Geyrhofer, <i>Collective fluctuations in the dynamics of adaptation and other traveling waves</i>
11:50 – 12:10		D. Fusco, <i>Excess of mutational jackpot events in growing populations due to gene surfing</i>
12:15 – 13:00		B. Sclavi, <i>The role of nucleoid organisation in growth rate dependence of gene expression and stringent response</i>
13:00 – 14:30		Lunch

Tuesday, June 14, 2016 — Afternoon session





14:30 – 15:00		A.Y. Weiße, <i>A mechanistic model of cellular growth</i>
15:00 – 15:30		K. Dorfman, <i>Microchemostats for single cell measurements</i>
15:35 – 16:00		Flash Talks
		S. Zaoli, <i>Supply-limited scaling of interrelated macroecological laws</i>
		A. Dal Co, <i>Spatial organization of bacterial mutualistic communities</i>
		Y. Himeoka, <i>Transitions among Log, Dormant, and Death Phases: Proposition of a simple model and quantitative characterization of dormancy and lag time</i>
		V. Sinha, <i>Decision strategies for competing phage infections</i>
		E.R. Hester, <i>From gene to function: quantitative modeling of nitrogen cycling bacteria associated with <i>Juncus acutiflorus</i></i>
16:00 – 16:30		Coffee Break
16:30 – 17:15		N. Mitarai, <i>Population dynamics of phage and bacteria: Diversity, Strategy, and Spatial structure</i>
17:15 – 18:00		K. Sneppen, <i>TBA</i>

Tuesday, June 14, 2016 — Late night session

21:15 –		J. Weitz, <i>Replicator dynamics and feedback-evolving games - new perspectives on the tragedy of the commons</i>
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Wednesday, June 15, 2016 — Morning session		
9:00 – 10:00		S. Maslov (Lecture)
10:00 – 10:45		A. De Martino, <i>Quantifying the trade-off between growth and its biosynthetic costs in E. coli</i>
10:45 – 11:00		Free time
11:00 – 11:30		Coffee Break
11:30 – 11:50		T. Biancalani, <i>Resource availability modulates the cooperative and competitive nature of a microbial cross-feeding mutualism</i>
11:50 – 12:10		B.P. Taylor, <i>The emergence of elevated rates of multiple infections in spatial microbe-virus dynamics</i>
12:15 – 13:00		C. Quince, <i>TBA</i>
13:00 – 14:30		Lunch




Thursday, June 16, 2013 — Morning session	
9:00 – 10:00	 E. Kussell (Lecture) <i>Relations between single-cell physiological parameters and bulk population growth</i>
10:00 – 11:00	 S. Tans (Lecture) <i>Growth variability and its relations to protein expression and cell size</i>
11:00 – 11:30	 Coffee Break
11:30 – 12:15	S. Maslov, <i>TBA</i>
12:15 – 13:00	S. van Teeffelen, <i>TBA</i>
13:00 – 14:30	 Lunch
Thursday, June 16, 2016 — Afternoon session	
14:30 – 15:00	C. Bosia, <i>Crossregulation and beyond: how stoichiometry controls microRNA-target synchronization</i>
15:00 – 15:30	G. Tiana, <i>The hierarchical structure of chromatin</i>
15:30 – 16:00	 Flash Talks
	A. Rosanova, <i>A stochastic Markov model highlights different evolutionary regimes for transcription factor families</i>
	C. Enrico Bena, <i>Quantitative physiology of cancer cell growth: from proteome partitioning to population responses</i>
	A. Colliva, <i>Entropic effects in chromatin folding</i>
	P. Thomas, <i>Stochastic gene expression in growing cell populations</i>
	M. Saltini, <i>Microtubule severing with growth reinitiation</i>
16:00 – 16:30	 Coffee Break
16:30 – 17:15	E. Kussell, <i>Evolutionary phase transitions in random environments</i>
17:15 – 17:45	R. Hermsen, <i>TBA</i>

Friday, June 17, 2016 — Morning session		
9:00 – 10:00		E. van Nimwegen (Lecture)
10:00 – 10:45		S. Tans, <i>TBA</i>
10:45 – 11:00		Free time
11:00 – 11:30		Coffee Break
11:30 – 11:50		T. Julou, <i>Monitoring Escherichia coli in changing environments with single cell resolution</i>
11:50 – 12:10		S. van Vliet, <i>The influence of cell-cell interactions on cellular decision making in bacteria</i>
12:15 – 12:45		N. Brenner, <i>TBA</i>
12:45 – 12:55		Flash Talks
		S. Mani, <i>Boolean models of vesicle traffic to study the evolution of complexity in the eukaryotic traffic system.</i>
		J. Rambeau, <i>Adaptation of B. subtilis in response to carbon source switching: a modelling approach</i>
13:00 – 14:30		Lunch



Week 2 — From interaction structures to collective behavior





Monday, June 20, 2016 — Morning session	
9:30 – 10:00	Welcome
10:00 – 11:00	 P. Cicuta (Lecture) Critical lipidomics: the consequences of lipid miscibility in biological membranes
11:00 – 11:30	 Coffee Break
11:30 – 12:15	T. Mora, <i>Statistical mechanics of real bird flocks</i>
12:15 – 13:00	A. Walczak, <i>Optimal immune systems</i>
13:00 – 14:30	 Lunch
Monday, June 20, 2016 — Afternoon session	
14:30 – 15:30	 N. Brenner, <i>Exploratory behavior of biological systems</i> (Lecture)
15:30 – 15:50	Y. Elhanati, <i>Statistical properties of immune receptors repertoires</i>
16:00 – 16:30	 Coffee Break
16:30 – 16:55	 Flash Talks
	S. Jacobsen, <i>Stress management: evolving mechanics of nascent multicellular organisms</i>
	N. Pellicciotta, <i>Understanding the role of hydrodynamic interactions in metachronal waves of human airway epithelium</i>
	M. Del Giudice, <i>Out-of-equilibrium crosstalk between microRNAs and targets</i>
	Q. Tang, <i>Critical fluctuations in proteins native states</i>
	J.L. Weissman, <i>TBA</i>
17:00 – 18:00	 R. Allen (Lecture) <i>How do antibiotics work?</i>




Tuesday, June 21, 2016 — Morning session



9:00 – 11:00		R. van der Hofstad (Lecture) <i>Information diffusion on random graphs: small worlds, percolation and competition</i>
11:00 – 11:30		Coffee Break
11:30 – 11:50		V. Domínguez-García, <i>Ranking species in mutualistic networks</i>
11:50 – 12:10		C. Stegehuis, <i>How community structure affects epidemics</i>
12:15 – 13:00		K. Kaneko, <i>Macroscopic theory of phenotypic adaptation and evolution: fluctuation-response, genetic assimilation, and slow-manifold hypothesis</i>
13:00 – 14:30		Lunch

Tuesday, June 21, 2016 — Afternoon session

14:30 – 15:15		N. Brenner, <i>Cellular adaptation with gene regulatory networks</i>
15:15 – 15:40		Flash Talks
		D.M. Busiello, <i>The origin of sparsity in living systems</i>
		S. Di Santo, <i>Self-organized bistability</i>
		B. Beltran, <i>Exploring the effects of cooperation in bacterial communities using stoichiometrically-explicit Lotka-Volterra models</i>
		E. De Lazzari, <i>Scaling laws in the functional content of bacterial genomes</i>
		A. Mazzolini, <i>Understanding the universality in the distribution of shared components</i>
15:40 – 16:00		Free time
16:00 – 16:30		Coffe Break
16:30 – 17:15		R. Allen, <i>Sticky bacteria and the growth of biofilms on surfaces</i>
17:15 – 18:00		P. Cicuta, <i>Emergence of collective dynamics in motile cilia: waves in the airways</i>

Wednesday, June 22, 2016 — Morning session		
9:00 – 11:00		H. Herrmann (Lecture) Packing of wires in cavities, bearings and growing surfaces
11:00 – 11:30		Coffee Break
11:30 – 12:15		R. van der Hofstad, <i>Information Diffusion on Random Graphs: Small Worlds, Percolation and Competition</i>
12:15 – 12:35		T.Y. Pang, <i>Metabolic modelling reveals evolution of complex phenotypes through adaptive steps of gene transfer</i>
12:35 – 13:00		Flash Talks
		Schreier, <i>Exploratory adaptation in large random networks</i>
		P. Villegas, <i>Kuramoto dynamics, glassy synchronization and rare regions in the human connectome</i>
		Y. Hao, <i>How popular do you want to be? A mathematical model of college friendship networks</i>
		A. Garavaglia, <i>Continuous time random graph model for citation networks</i>
		P. Villa Martín, <i>Opportunity to elude catastrophic shifts</i>
12:45 – 13:00		Free Time
13:00 – 14:30		Lunch

Thursday, June 23, 2016 — Morning session	
9:00 – 9:45	M.A. Muñoz, <i>Self-organization to the edge of bistability</i>
9:45 – 10:30	A. Maritan, <i>A stochastic model for ecosystems with non trivial stationary states</i>
10:30 – 11:00	A. Giometto, <i>A generalized receptor law governs phototaxis in the phytoplankton <i>Euglena gracilis</i></i>
11:00 – 11:30	 Coffee Break
11:30 – 12:00	S. Suweis, <i>Optimization and localization in ecological mutualistic networks</i>
12:00 – 12:30	J.A. Bonachela, <i>Emergent patterns and ecological interactions: the termite case</i>
12:30 – 12:50	W.K. Chang, <i>Molecular drivers of bacteriophage infection in the Nahant ecosystem: an information theoretic analysis</i>
13:00 – 14:30	 Lunch
Thursday, June 23, 2016 — Afternoon session	
14:30 – 15:00	P.D. Dixit, <i>Maximum entropy inference of rate parameter distributions and population heterogeneity in signalling network kinetics</i>
15:00 – 15:50	T. Parsons, <i>Scaling from the microscopic to the macroscopic in complex eco-evolutionary models: a host-pathogen example (I)</i>
16:00 – 16:30	 Coffee Break
16:30 – 17:15	E. van Nimwegen, <i>TBA</i>

Friday, June 24, 2016 — Morning session	
9:00 – 9:45	T. Parsons, <i>Scaling from the microscopic to the macroscopic in complex eco-evolutionary models: a host-pathogen example (II)</i>
9:45 – 10:30	K. Sneppen, <i>TBA</i>
10:30 – 10:50	J. Hidalgo, <i>Impact of environmental noise in the biodiversity of neutral communities</i>
11:00 – 11:30	 Coffee Break
11:30 – 11:50	R. Martínez-García, <i>Lack of ecological and history information can create the illusion of social success in Dictyostelium discoideum</i>
11:50 – 12:35	A. Maritan, <i>Variational principles in living systems</i>
12:40 – 13:00	Closure
13:00 – 14:30	 Lunch

Speaker information

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