NOBEL SYMPOSIUM 215 — Beyond Boltzmann: Complexity, Memory, and Non-Additive Entropies

Monday, 24 May 2027 - Friday, 28 May 2027

Bäckaskog slott

Scientific Programme

Beyond Boltzmann

NOBEL SYMPOSIA 215 examines when generalized entropies provide consistent, predictive descriptions of systems shaped by memory, strong correlations, constraints and long-range interactions. Six plenary sessions connect foundations and microscopic dynamics with experiments, observations, quantum theory and data-rich sciences.

The programme comprises **29 planned invited talks and two dedicated 30-minute discussions in each session**. Contributions identify the mechanism or derivation linking their results to the symposium theme and the evidence that distinguishes competing interpretations.

A shared set of questions

Which entropy is physically admissible, and under what conditions?
What dynamical mechanism generates the observed statistical law?
Which measurements distinguish a physical explanation from a fit?
What decisive calculations, experiments or observations should come next?

On Friday, six rapporteur summaries feed into a Round Table and consideration of a brief Symposium Statement, followed by a planned open-access scientific report. The Wednesday early-career forum brings emerging research into the discussion.

Scientific sessions: Tuesday 25 May–Friday 28 May 2027 at noon, Bäckaskog slott. The symposium begins with a Monday reception in Lund and closes with the Friday public lecture.

The programme is preliminary and will be updated as titles, participants and practical arrangements are confirmed. All times in the timetable are local to Sweden.

S1 · Foundations and admissible generalized entropies

Definitions, admissibility, composability and thermodynamic consistency establish the common language of the symposium. Topics include generalized entropy classes, accessible-state scaling, group entropies, superstatistics and the foundations of nonextensive statistical mechanics.

Discussion focus: Which generalized entropies are physically meaningful, under what conditions do they apply, and which observations distinguish among them?

S2 · Weak chaos, memory and anomalous transport

Dynamical routes to q-statistics through edge-of-chaos scaling, slow mixing, memory and nonlinear diffusion. Low-dimensional maps, Hamiltonian lattices and nonlinear Fokker–Planck descriptions connect microscopic dynamics to statistical limit laws and anomalous transport.

Discussion focus: How do these mechanisms generate non-Boltzmann statistics, and how can finite-time effects, finite-size effects and competing explanations be tested?

S3 · Many-body systems, turbulence and granular matter

Correlated many-body systems provide physical tests of generalized statistical descriptions. Topics span turbulence, q-Gaussian spectral crossovers in glasses and correlated random matrices, controlled granular experiments, long-range Hamiltonian quasi-stationary states and turbulent plasma kinetics.

Discussion focus: Connecting mechanisms to experiments, simulations and observations, and establishing decisive benchmarks across these systems.

S4 · Nonextensivity in particle physics

Non-exponential laws in particle and heavy-ion collisions connect statistical descriptions with strongly interacting matter. Topics include q-exponential spectra, thermofractality and QCD self-similarity, femtoscopy, finite or fluctuating reservoirs, composition laws and transport in hot and magnetized QCD matter.

Discussion focus: Which microscopic mechanisms account for observed statistical laws, and which collision observables discriminate among their interpretations?

S5 · Quantum information, black holes and cosmology

Quantum theory and gravity bring distinct questions about entropy into view. Topics include generalized information measures, Tsallis and Rényi entropies, group entropies, horizon thermodynamics, holography and cosmological tests. Routes to extensivity through generalized variables, formal logarithms or additional work terms will be compared.

Discussion focus: Distinguishing thermodynamic consistency from quantum-information questions, and identifying theoretical or observational tests of alternative descriptions.

S6 · AI and data-rich complex systems beyond traditional physics

The final thematic session tests generalized statistical ideas beyond traditional physics. Topics include sparse machine learning, nonlinear prediction, complex networks, data-rich ecosystems and statistical seismology, under the same standards of mechanism and evidence used throughout the symposium.

Discussion focus: How are entropy and composability structures realized in networked and data-rich systems, and when do they improve understanding or prediction relative to alternative

models?