Precision Physics with Jet Observables
Thomas Gehrmann
(Zurich University)
Jet production observables are among the most sensitive probes of QCD at high energy colliders, where they are used for example to determine parton distributions and the strong coupling constant. Until recently, the interpretation of jet production data within perturbative QCD was restricted to next-to-leading (NLO) calculations, with theoretical uncertainties being considerably larger than current experimental errors. We report on developments towards NNLO calculations of jet observables at high energy colliders and discuss the potential implications of these corrections for precision QCD physics.

IceCube and the discovery of high energy neutrinos from extraterrestrial sources
Tom Gaisser
(University of Delaware Department of Physics and Astronomy)
IceCube is a kilometer scale detector at the South Pole consisting of 4500 optical sensors that detect cosmic rays and neutrinos. The main array is shielded by 1.5 km of ice so that it can identify and reconstruct events generated by neutrinos, which are relatively rare compared to the background of atmospheric muons and neutrinos. IceCube recently discovered the first evidence for neutrinos of high energy from extraterrestrial sources. In this talk I will describe the data and explain the significance of such a discovery. I will also describe how IceCube measures the spectrum of cosmic-ray particles and their relation to the neutrinos.

Dynamical Clustering and the Mechanism for Raft-like Structures in a Model Lipid Membrane
Francis Starr
(Wesleyan University, USA)
We investigate the dynamical heterogeneity of a model single-component lipid membrane using simulations of a coarse-grained representation of lipid molecules. In the liquid-ordered (LO) phase, lipid diffusion is hindered by the transient trapping of molecules by their neighbors, giving rise to two distinct mobility groups: low-mobility lipids which are temporarily caged*, and lipids with displacements on the scale of the intermolecular spacing. The lipid molecules within these distinct mobility states cluster, giving rise to transient islands* of enhanced mobility having the size and time scale expected for lipid rafts*. Although the dynamic lipid clusters we observe do not themselves correspond to rafts (which are more complex, multicomponent structures), we hypothesize that such rafts may originate from the same universal mechanism, explaining why raft-like regions should arise, regardless of lipid structural or compositional details. Additionally, the geometry of these clusters can be understood in the context of percolation theory. This perspective provides a new approach to examine membrane transport.

On the avoidance of Classical singularities in Quantum Cosmology
Claus Kiefer
(University of Cologne - Germany)
It is often claimed that a consistent theory of quantum gravity should avoid the singularities predicted by classical General relativity. While a general answer is not yet known, the fate of singularities can be investigated within simple models. In my talk, I shall discuss the quantum avoidance of classical singularities in quantum cosmology. I shall, in particular, address models where classically a singularity develops for large scale factors, such as a Big Rip or a Big Brake, and for which a quantum version without singularities exists. The discussion is performed within quantum geometrodynamics, that is, the Wheeler-DeWitt equation, but remarks are also made concerning the corresponding situation in loop quantum cosmology.

Roles of Dry Friction in Fluctuating Motion of Adiabatic Piston
Tomohiko Sano
(Yukawa Institute, Kyoto)
Recent developments in experimental technique enable us to control small systems and non-equilibrium systems to clarify their thermodynamic structures, in detail. One of the most important applications of manipulation techniques for small systems is the design of nano-machines or sub-micron machines. The difficulty to realize efficient small machines is the existence of dry friction when two solids are in contact, because the dry friction wears down the small machines. Because the dry friction is ubiquitous throughout nature, to control systems under dry friction is indispensable to make small machines. Experiments for macroscopic systems under the dry friction reveal that the dry friction has an important role to rectify unbiased fluctuations, i.e. to extract work from an equilibrium environment. Although the dry friction plays essential roles in non-equilibrium transport, the energetics for the systems under the dry friction has been elusive so far. In this seminar, we consider the fluctuating motion of an adiabatic piston under dry friction to clarify the roles of dry friction in non-equilibrium steady states. Introducing the stochastic equation of motion for the piston driven by white non-Gaussian noises, we clarify that the dry friction can reverse the direction of the piston motion and causes a discontinuity or a cusp-like singularity for velocity distribution functions of the piston. We also show that the heat fluctuation relation is modified under the dry friction. In the last part of the talk, the thermodynamic efficiency or power for the engine which contains the fluctuating boundary are analyzed through the extension of the model for the fluctuating piston.