Speaker: Thomas Franosch, Innsbruck University, Austria

Title: **Persistent correlations in dilute Brownian suspensions in equilibrium and their fate upon strong driving**

The equilibrium dynamics of Brownian is expected to display persistent long-time tails in the velocity-autocorrelation function due to repeated collision events of pairs of particles. Although this prediction has been made some 40 years ago for the case of dilute suspensions [1] their observation in simulations has remained a challenge due to poor statistics. Only recently we designed a noise suppression algorithm that allows unraveling these tails [2]. We demonstrate that the tails persist to all densities and compare the simulations to predictions from the mode-coupling theory of the glass transition. In the second part, we drive the system out of equilibrium by applying a strong external step-force force on a single probe particle in the Brownian suspension [3]. We monitor the time-dependent drift velocity as the system approaches the steady state. We elaborate analytically, exact to first order in the density, the moment-generating function of the displacement and extract the average drift velocity and its fluctuations. The time-dependent drift velocity approaches its stationary state value exponentially fast for arbitrarily small driving in striking contrast to the power-law prediction of linear response encoded in the long-time tails of the velocity autocorrelation function. We show that the stationary-state behavior depends nonanalytically on the driving force and connect this behavior to the persistent correlations in the equilibrium state. We argue that this relation holds generically. Furthermore, we elaborate that the fluctuations in the direction of the force display transient superdiffusive behavior which can be rationalized within a simple toy model.

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[3] S Leitmann, O Bénichou, T Franosch, Time-dependent dynamics of the three-dimensional driven lattice Lorentz gas, Journal of Physics A: Mathematical and Theoretical 51, 375001 (2018).