

The fascinating diversity of material behavior at the macroscopic scale can only emerge from the underlying atomistic or particle behavior. Yet, the direct connection between these two scales remains an extremely challenging quest, particularly in the context of non-equilibrium phenomena. In this talk, we will discuss several advances in this direction, in the context of plasticity, thermoelasticity, diffusion and viscous dissipation. In all these cases, the importance of fluctuations in the effective response will become apparent. More precisely, these will provide crucial information for the material description and evolution at the continuum scale, where the behavior is modeled as deterministic and free of fluctuations.