Symposium | M. Time- and History-Dependent Material Properties

[SY-M1]Symposium M-1

Chair: Thomas Voigtmann(German Aerospace Center, Cologne, Germany)
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[SY-M1]Soft deformable colloids make strong liquids with stress-driven relaxation

Invited

Nicoletta Gnan, ○Emanuela Zaccarelli (CNR Institute for Complex Systems, Rome, Italy)

Fragility is a key concept in the glass transition which describes the dependence of the structural relaxation time on the control parameter (packing fraction ϕ or temperature) upon approaching dynamical arrest. Recently, Mattson et al[1] showed a connection between softness and fragility in colloidal systems, but a deep understanding of its microscopic origin still remains elusive. Numerical simulations represents a strong ally to elucidate this problem, but in most cases softness is tuned by modifying the pair-potential parameters allowing particles to overlap to a certain extent, while neglecting crucial aspects that contribute to the elastic properties of realistic particles. On the other hand, more refined numerical models of soft particles are challenging to simulate due to the presence of internal degrees of freedom of high computational cost. As a consequence simple models like the Hertzian potential cannot capture mechanisms such as particle deformations, making the concept of "softness" in simulations and experiments very different.
To fill this gap, I will discuss a new model of 2D polymer rings with tunable softness which undergo substantial deformation at high densities. The ability to deform has a strong impact on the dependence of the relaxation time on ϕ which change from fragile-to-strong behavior. In addition, at high packing fractions, dynamics is controlled by an intermittent particle motion which gives rise to a compressed exponential decay of the self-intermediate scattering function. This behavior can be rationalized in terms of deformed rings that act as stress dipoles[2,3]. This simple model thus provides microscopic insights into two mechanisms which are of a deep interest in soft matter: the fragility dependence on softness and the occurrence of a compressed exponential decay in dynamical correlation functions.
[1] J. Mattsson, H. M. Wyss, A. Fernandez-Nieves, K. Miyazaki, Z. Hu, D. R. Reichman and D. A. Weitz, Nature 462, 83 (2009).
[2] L. Cipelletti, S. Manley, R. C. Ball and D. A. Weitz, PRL 84, 2275 (2000).
[3] E. E. Ferrero, K. Martens and J.-L. Barrat, PRL 113, 248301 (2014).