What distinguishes a complex system from a simple?

Jeppe Dyre

Roskilde University, Denmark

Email: dyre@ruc.dk

Abstract:

Many systems in soft matter have intriguing and complex phase diagrams. This applies even for the apparently simple model defined by the radially symmetric Gaussian core potential. This example shows that it is not just the existence of multiple time and length scales that makes a system complex, thought in practice this is often the case. We here argue that simple systems are those with an (approximate) hidden scale invariance [1], and that complex systems are those without such. Hidden scale invariance refers to the property that a change of density merely leads to a linear (affine) transformation of the potential energy surface. This property implies the existence of isomorphs, which are curves in the thermodynamic phase diagram along which structure and dynamics are invariant in properly reduced units [2]. It also implies a separation of the equation of state such that temperature is the product of a function of density and a function of excess entropy.

References :

1. J. C. Dyre, Phys. Rev. E 88, 042139 (2013).
2. N. Gnan et al, J. Chem. Phys. 131, 234504 (2009).